A structural analysis of the decline of home-cooked food * Preliminary and incomplete*

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Abstract

The share of home-cooked food in the diet of households has declined considerably over the past few decades across the developed world. We develop and estimate a structural model of food consumption and time use to understand the key driving forces. We show that the market price of ingredients for home cooking has *declined* relative to the price of ready-to-eat foods. However, once we account for the fact that cooking takes time we find that the opposite is true - the shadow price of home-cooked food has risen relative to ready-to-eat food. This is because there has been an the increase in the market value of time of secondary earners. We show that increased taxes alone would not be sufficient to incentivise households to shift back to home-cooked food.

Keywords: food, consumption, time use, shadow prices, AIDS.

JEL codes:

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1 Introduction

Households in the developed world have shifted away from home-cooked food towards ready-to-eat food to a substantial extent over the past few decades. In the UK, home-cooked food represented close to two thirds of the food budget in 1980, but less than a third in 2000. This is an enormous change, which has been associated with equally important changes in life-style and time use, and in particular changes in labour market behaviour of secondary earners. This change in diet has been proposed as one of the likely candidate causes of the growth in obesity and decline in the nutritional quality of diets, and there is considerable interest in understanding what has driven this change in order to help design policies to reverse it.

The increase in the consumption of ready-to-eat foods has been linked to adverse health outcomes, such as obesity, as well as to negative impacts on cognitive outcomes, particularly amongst children, among others by Case et al. (2002), Heckman (2007), Anderson et al. (2003a), Anderson et al. (2003b), Baum and Chou (2011), Cawley (2000), Goldman et al. (2009), Herbst and Tekin (2011), Mackenbach et al. (2008). This has led to calls for policy intervention aimed at changing eating habits, see for example Bhattacharya and Sood (2011), Brunello et al. (2009), Finkelstein and Zuckerman (2008), Gortmaker et al. (2011), Philipson and Posner (2008), Dobbs et al. (2014)), and promote a healthy, balanced diet.

Our contribution in this paper is twofold. First, we document a number of interesting trends. Over the period 1980 to 2000 the price of ingredients for home cooking has actually decreased relative to that of ready-to-eat alternatives (both eaten at home and out). This leads to a puzzle, assuming that both types of food are normal goods, then we would expect their consumption to increase and for the consumption of ingredients to increase by more. We show that there have also been big changes in time use, and in particular in the labour market participation of secondary earners, and a decrease in time spent cooking.

Second, we develop a structural model of food consumption and time use, with home production, which we estimate on UK data. Our model is based on the insight from Becker (1965) that consumption comes from the combination of market goods and time, so that it is the shadow prices of goods (their market price plus the opportunity cost of the time needed to produce them) that determine choices. There is a literature that establishes the importance of non-separabilities between consumption and time use, for example, Browning and Meghir (1991), or Blow et al. (2014) who test for separability between time use and consumption in preferences in the CEX and reject. Our model is in the tradition of Barten (1964), in specifying that household composition acts as price deflators. We follow Deaton and Paxson (1998), with economies of scale in food consumption, and Crossley and Lu (2018), with economies of scale in food preparation. In our model, there is food preparation with heterogenous time costs and two agents contributing time to home cooking. We study the choices households make between ready-to-eat food, requiring no preparation time, and home-cooked food, requiring the combination of time together with ingredients to be produced. The heterogeneity in time costs is extreme, since ready to eat food requires no preparation and home cooked food requires time to be combined with ingredients in fixed proportions to be produced.

On the consumption side, the model incorporates trade offs between purchasing ingredients for cooking or purchasing ready-to-eat food. We allow for potential economies of scale in cooking, which might also have increased the costs of home production, since household size has declined. On the time use side, the model accounts for trade offs between working to earn an income, cooking and leisure. We do not have information about the uses of time when not working. We assume that time spent cooking and ingredients are complements in the production of home-cooked food. We evaluate full income - the sum of expenditures and the imputed cost of time spent not working. To do this we have to impute the value of time, i.e. a potential wage for the individuals that are not working. This, together with the structural model, enables us to recover the elements of the behavioural model.

The model allows us to recover the shadow price of home-cooked food, which incorporates the opportunity cost of time as well as the price of ingredients and returns to scale in food preparation. This helps to explain the shift from ingredients used for home cooking to ready-to-eat foods, because the rising opportunity cost of time has increased the shadow price of home cooking.

We use the UK Family Expenditure Survey and distinguish labour intensive and non labour intensive food. We are able to track consumption and prices over the period 1980 to 2000. Women's labour force participation and hours worked have increased, as have real wages, thus making time spent cooking more costly in terms of foregone earnings. In addition, household size has decreased, reducing the opportunity to exploit economies of scale generated by cooking for a larger numbers of individuals.

We find that accounting for the opportunity cost of time is important to explain households; food choices. Changes in the labour market affect the market value of time and the relative attractiveness of home production. This means that the shadow price of ingredients differs significantly from the market price; we are able to explain the evolution of the structure of the food budget over the period

1980 to 2000 and explain away the apparent puzzle that is present when conditioning on food prices and incomes.

We estimate the elasticities of demand for home-cooked food to market prices and shadow prices of time and ingredients, which are themselves functions of household size and labour market participation. We use these estimates to assess the importance of changes in labour market conditions (real wage offers and participation opportunities), and in prices and demographics (e.g. changes in household size) to better understand the rise in the consumption of ready-to-eat food over the period.

We use the model to perform counterfactual analysis. We show that the level of tax required to shift households choices away from ready-to-eat food towards ingredients and home-cooked food is not sustainable, because food choices are driven by wages to a much larger extent than by prices.

The availability of ready-to-eat food means it is possible to spend less time cooking, which could be welfare enhancing, for instance if parents spent the time gained with their children. Unless we know how households use the time that is freed up by not having to cook, it is not possible to evaluate the net effect of the increased availability of ready-to-eat food on behaviour and thus welfare more broadly. It would be interesting to know for instance whether parents use the time thus acquired to look after their children, or increase participation and hours of work.

The structure of the paper is as follows. In section 2 we describe trends in the evolution of food consumption, market prices, labour force participation and household size between 1980 and 2000 in the UK. We also present cross section evidence. In section 3 we present a structural model of food consumption and time use with home production. In section 4 we discuss the empirical specification. In section 5, we present the estimates of the structural model, and we present counterfactuals in section 6. A final section concludes.

2 Reduced form evidence

We document a substantial decline in home-cooked food and increase in ready-to-eat foods. We relate these to trends in market prices; labour market participation and time use; wages and household size. We show that in the cross-section, expenditure on home-cooked food as a share of the household's total food expenditure is correlated with characteristics, such as female employment and wage, and that time spent on food preparation is correlated with household characteristics. These correlations point to the possibility that improved labour market opportunities for secondary earners (largely females) and a reduction in household size led to a reduction in demand for home-cooked food. This reduced form evidence guides the assumptions we make in developing the structural model in Section 3.

We use data on expenditure, wages, labour force participation and hours of work from the UK Family Expenditure Survey and Expenditure and Food Survey (FES/EFS) for the period 1980-2000. This is a nationally representative repeated cross-section. We focus on households with two adults and any number of dependent children (including zero), where both adults are of working age (25-60), and where the head of household works full-time. We omit households with self-employed individuals (whose hours of work are not recorded in the data), as well as households in which either member is involved in a work-related government training programme. This gives us a sample of 38,291 households.

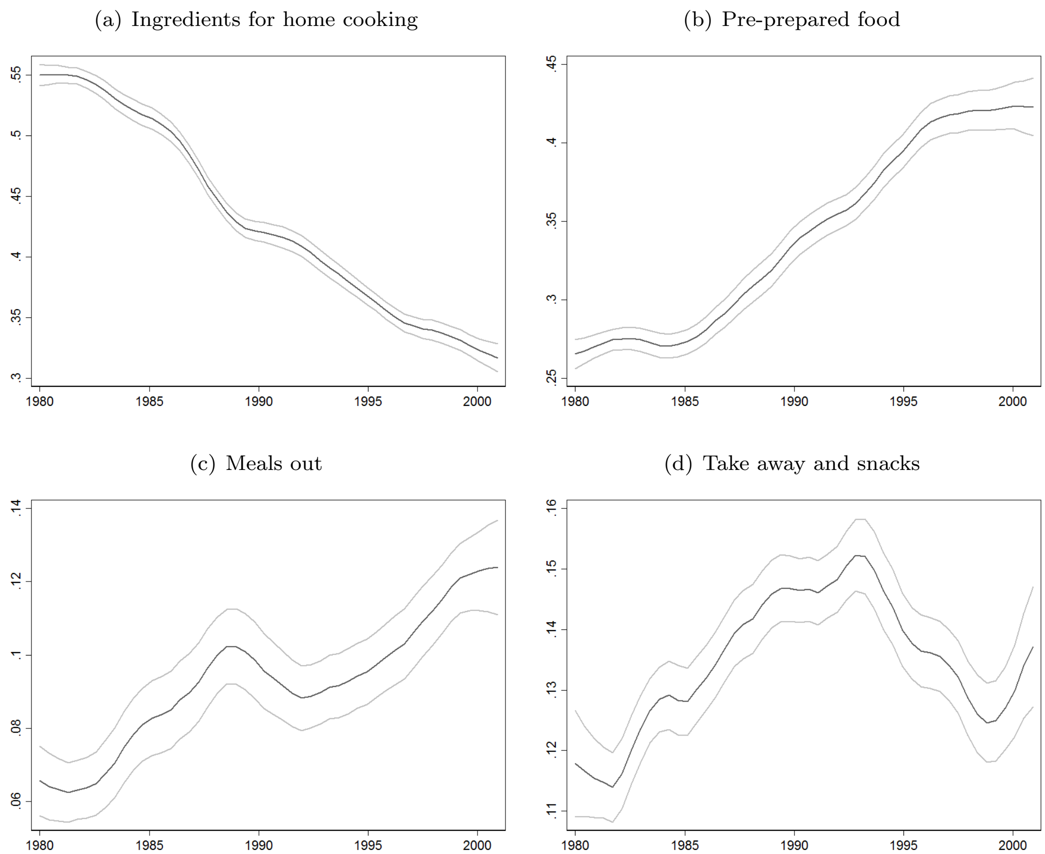
Selecting on households where the head works full-time allows us to treat the hours of the main earner as exogenous, and simplifies modelling considerably. In fact, this does not impose that much structure on the data, since labour force participation of male heads of household in the age range 25-60 is very high, and there is very little variation in hours worked (conditional on working full-time). We also assume that there are no frictions on the labour market, so that unemployment is voluntary. In the absence of frictions, the value of time is the wage (or the potential wage).

The data give details of expenditure on 367 food categories. We map these into four aggregate categories - home-cooked food, pre-prepared food eaten at home, meals out, and take away and snacks. Appendix A.1 shows how foods are aggregated into relevant food groups. We measure prices using the ONS Retail Price Index (RPI) price series. There are 30 price indices for foods available that we can use; we construct a price index for each of the aggregated food categories as detailed in Appendix A. Information on time use and time spent on food preparation comes from two cross-sectional surveys: People's Activities and Use of Time (1974-1975) and the 2000 Time Use Survey.

2.1 Food consumption

The share of expenditure on ingredients for home-cooked food declined dramatically from 1980 to 2000, see Figure 2.1. In 1980, on average, close to 58% of the food budget was allocated to home-cooked food, with the remaining 42% split between food purchased ready-to-eat at home, meals out and take away and snacks. By 2000 the share of ingredients for cooking at home had halved, from 58% to 28%. The share of pre-prepared food had risen from 26% to 44%, while the share of expenditure on meals out has almost tripled, from 4.7% to 15%. The share of take away and snacks has increased until around 1994, decreased until about 1999 and increased again. The distinction we make between the food aggregate "processed food" and the food aggregate "take away and snacks" is not entirely due to the nature of the foods, but to the collection method. In both processed food and take away and snacks, we have foods that are bought ready to eat, and eaten at home. For pre-prepared food, the data is collected by a diary method; whilst for take away and snacks, the data was collected by a different set of methods, leading to some issues with the data. Over part of the period 1980 to 2000, data on meals out and take away and snacks was collected by asking one individual to recall all expenditures on these foods made by all individuals of the household. This is a particularly unreliable method of data collection and the data is consequently noisy. Subsequently, all household members were provided with diaries and tasked with reporting information on meals out and take away and snacks over a suitably chosen recording period. This led to some improvement over the recall method by one individual, but the quality of this data remains inferior to the quality of the data on expenditures on ingredients and processed foods because of recall issues Furthermore, what constitutes "Meals out" is a heterogenous aggregate, in terms of the activity it constitutes, and of the time involved, from eating a meal in a fancy restaurant to picking up a meal in a fast food restaurant. Similarly, what constitutes "Take away and snacks" is even more varied, and changed considerably over the period, thanks to supply side effects and to changes in the survey definitions of the goods.

Figure 2.1: *Budget shares of food aggregates*

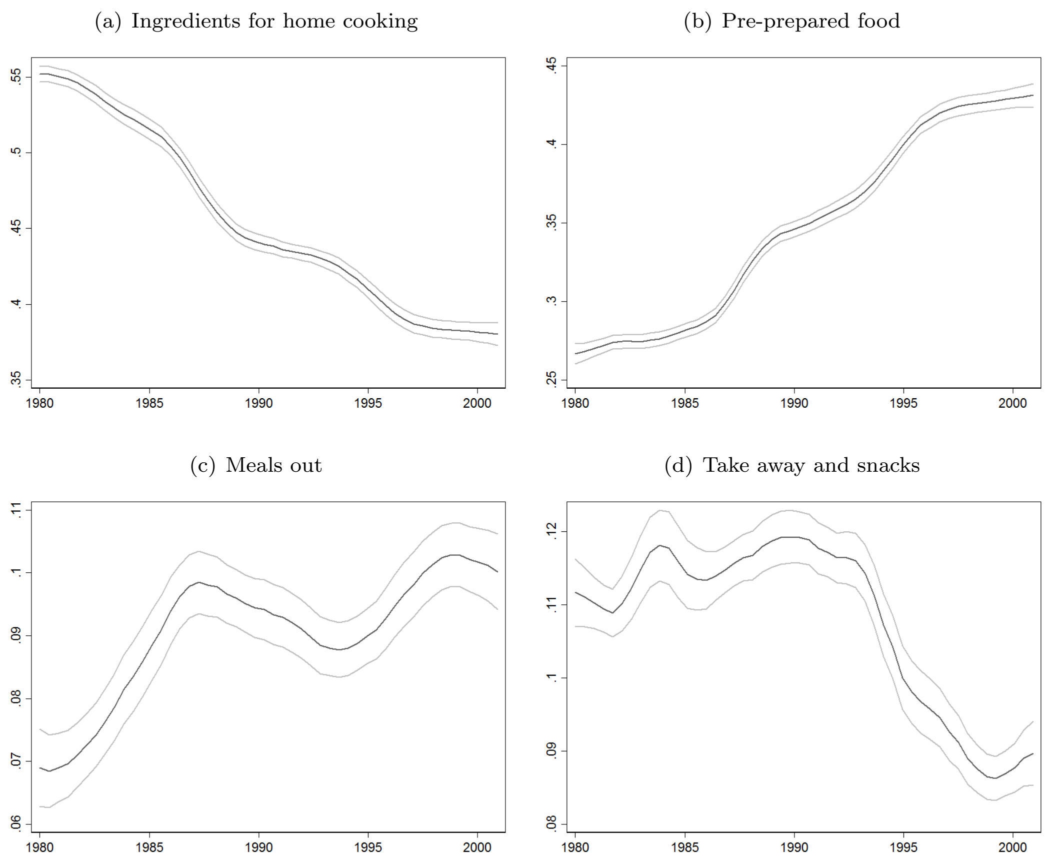


Note: Sample of 38,291 households with two adults aged 25-60, with any number (including zero) of dependent Children. Solid line is a fitted local polynomial and lighter lines are 95% confidence intervals.

We are ultimately more interested in changes in quantities than in changes in expenditures; changes in budget shares could reflect changes in relative prices as well as changes in quantities. To establish what has happened over time to quantities consumed, figure 2.2 shows budget shares expressed in constant 1980 prices. For ingredients for home cooking and pre-prepared food there is not much difference between the evolution of the budget shares and the evolution of the quantities consumed through time. The quantities of ingredients purchased for cooking at home have decreased dramatically, while the quantities of pre-prepared foods have increased as a mirror image. For meals out and takeaways and snacks, the trends differ. While the increase of the share of expenditure on meals out over the period in current prices is gradual, the increase in constant 1980 prices occurs mostly at the beginning of the period, between 1980 and 1985. In other words, the quantity increased first, followed by prices.

Finally, the share of take away and snacks in constant 1980 prices has decreased since 1990, indicating a decrease in quantity consumed of these foods.

Figure 2.2: *Budget shares of food aggregates in constant 1980 prices*

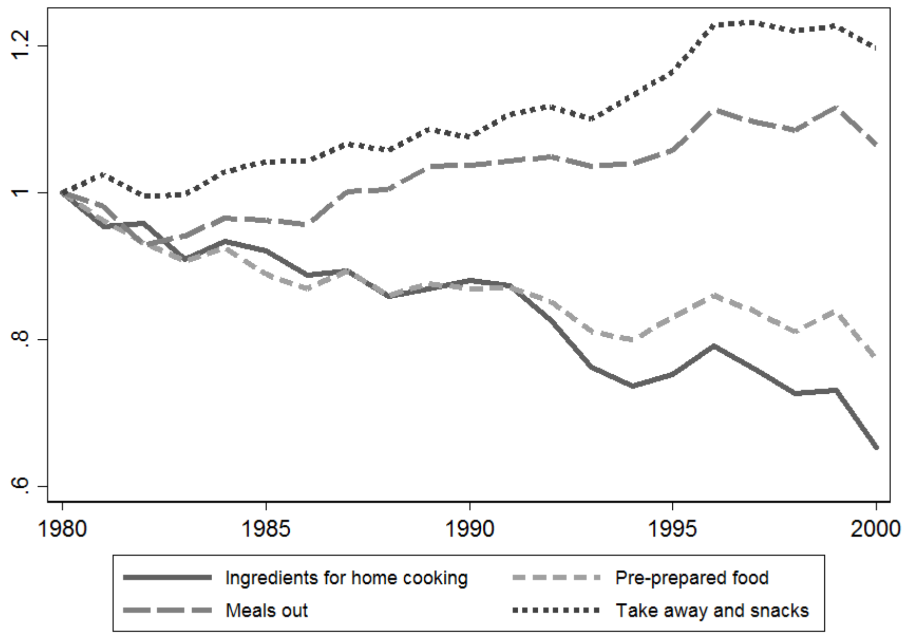


Note: Sample of 38,291 households with two adults aged 25-60, with any number (including zero) of dependent children. Solid line is a fitted local polynomial and lighter lines are 95% confidence intervals.

2.2 Market prices

Market prices for ingredients for home cooking and processed foods fell over the 1980s and 1990s, with the market prices of ingredients falling the most, by close to 35%, and the prices of pre-prepared foods by about 25%. Over the same period, the price of meals out has risen by about 10% and that of take away and snacks by 20%, as shown in Figure 2.3.

Figure 2.3: *Market prices of food aggregates*



Note: Prices of aggregates constructed from ONS price series, relative to the price of the outside good

This leads to a puzzle. The prices of both ingredients and pre-prepared food decreased from 1980 to 2000, yet the consumption of ingredients has fallen while that of pre-prepared food has increased. From 1990 to 2000 the price of ingredients fell more than that of pre-prepared food, but the consumption of pre-prepared foods continued to increase while that of ingredients for home cooking continued to decrease.

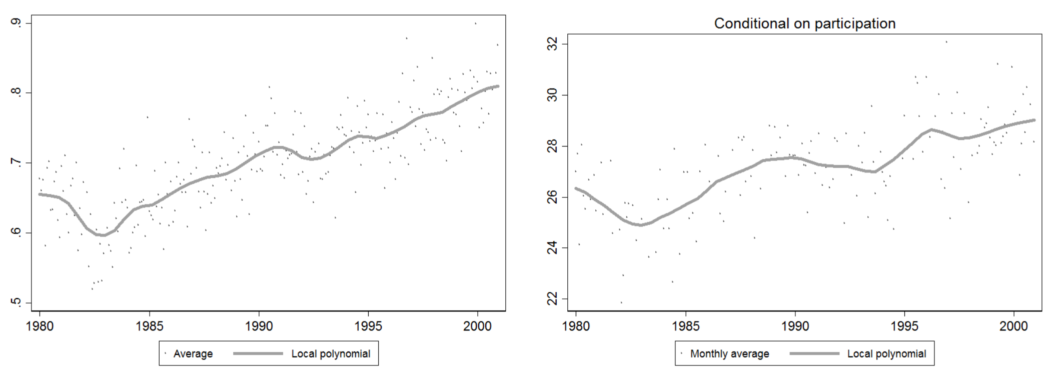
We show that the opportunity cost of time has risen as real wage offers and labour market participation for secondary earners have increased, which means that the shadow price of ingredients has increased.

2.3 Labour force participation and wages

The last three decades have seen changes in the use of time and these have differed for males (usually the main earner in two adult households) and females (usually the secondary earner in two adult households, particular when children are present in the household). Most working age males participate in the labour market, and they mostly work full time. Female labour force participation has increased significantly over this period, with participation rising from about 55% to about 85% (see figure 4(a)) and conditional on working, average weekly hours have increased from about 22 to 33 hours (see figure 4(b)). Altonji and Blank (1999) and Costa (2000) document similar trends in female labour market participation for the US. Meanwhile, the rise in female labour force participation and the narrowing of the gender wage gap have been described and investigated in a large body of literature.

Figure 2.4: *Labour force participation of females*

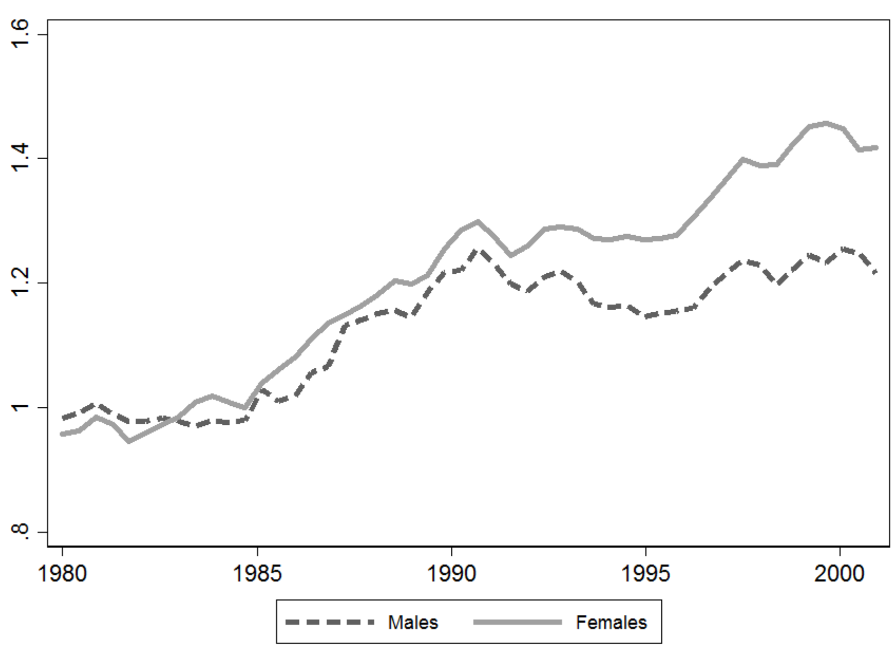
(a) Labour force participation (b) House worked, conditional on participation



Note:

Real wage have grown for males and more so for females, as shown in Figure 2.5, about 40% for females and 20% for males.

Figure 2.5: *Real wages of head and secondary earners, conditional on participation*



Note: Average real wages relative to January 1980

2.4 Time use

We use the UK Time Use Survey 2000 (TUS) and the People's Activities and Use of Time, 1974-1975 (PAUT) to describe changes in time spent on food preparation. The TUS is a nationally representative cross-sectional survey of 12,000 individuals aged 8 or older. Participants complete a diary detailing their main and secondary activity for each 10 minute slot over two 24 hours periods. We report time spent on the following activities as food management: "unspecified food management", "food preparation","baking","dish washing","preserving", and "other specified food management". The PAUT is a survey of 1,941 individuals aged 5 or older in which individuals record the main and secondary activities for every half-hour slot from 5am to 2am over seven days. We use information on time spent on "preparing meals and making food", which includes: "cooking", "washing up", "clearing away", "baking", "peeling vegetables". We use data on individuals in households with two adults and any number of dependent children (including zero), where both adults are of working age (25-60), and where the head of household works full time. We omit households with self-employed individuals (whose hours of work are not recorded in the data), as well as households in which either member is involved in work related government training programme. This gives us a sample of 2,137 households in the TUS.

In 2000, females spent on average 8.3 hours a week on food management as the main activity, while the male average (including zeros) is 3.3 hours (Table 2.1). The gender gap in food management hours is bigger on weekdays than on weekends. The gap is also much bigger in the subsample of couples where the female does not work, than the ones where the female works. Time spent on food management differs from that in the mid 1970s. In 1974-5, the average female time on food management was higher at 13.3 hours (compared to 8.3 in 2000). The decline in female hours spent on food preparation is observed across the distribution. By contrast, the average hours that males spent on food management increased from 1.3 to 3.3 over the period, a big proportional increase but there remains an overall decline in the total hours spent by the couple on food management.

Table 2.1: *Time spent on food management*

		% > 0	mean	Hours per week exc. zeros			
			inc.0	mean	25th pct	median	75th pct
Male							
main activity	1974	0.586	1.3	2.2	0.5	1.5	3.0
	2000	0.815	3.3	4.1	1.5	3.2	5.7
secondary activity	1974	0.262	0.3	1.1	0.5	1.0	1.5
	2000	0.120	0.2	1.9	0.7	1.0	2.5
Female							
main activity	1974	0.985	13.3	13.5	9.5	13.0	17.0
	2000	0.971	8.3	8.6	4.3	7.8	12.0
secondary activity	1974	0.733	1.6	2.2	1.0	1.5	3.0
	2000	0.263	0.6	2.1	0.8	1.3	2.7

Note: Sources: Weekly hours. UK Time Use Survey 2000 (TUS) and the People's Activities and Use of Time, 1974-1975 (PAUT)

Table 2.2: *Time spent on food management in 2000, conditional on secondary earner labour market status*

	% > 0	mean	Hours per week exc. zeros			
		inc.0	mean	25th pct	median	75th pct
Male						
secondary earner not in work	0.782	2.9	3.7	1.3	2.7	5.5
secondary earner in work	0.827	3.4	4.2	1.7	3.2	5.8
Female						
secondary earner not in work	0.987	11.2	11.4	7.3	11.2	15.0
secondary earner in work	0.966	7.5	7.8	4.0	7.2	10.8

Note: Sources: Weekly hours. UK Time Use Survey 2000 (TUS) and the People's Activities and Use of Time, 1974-1975 (PAUT)

These trends are also observed in the US. Bianchi et al. (2000) document a 12.5 hours/week reduction in total female housework hours between 1965 and 1995. About two-thirds of that overall reduction comes from cooking meals and meal clean-up (8.5 hours). Similarly, Smith et al. (2013) documented that between 1965-66 and 2007-08, the amount of time spent in food preparation more than halved for females and nearly doubled for males in the US.

2.5 Household size

There has been a reduction in household size, thus decreasing the scope for households to exploit economies of scale in food preparation. The reduction in household size is primarily due to a reduction in the number of adults, going from 2.2 on average in 1980 to just under 2 in 2000. The number of dependent children in UK households remains around 1.4 on average over the period. We analyse the behaviour of households composed by two adults and any number of children, so economies of scale are not going to play an important role quantitatively in our application.

2.6 Cross section evidence

We expect families with a lower cost of time and a larger number of children to choose more home-cooked food over pre-prepared food. This intuition is confirmed by cross-sectional evidence. First, we see that the share of home-cooked food is negatively correlated with labour supply and real wages of the secondary earner, and positively correlated with the number of children. In Table 2.3, we show the correlation of the share of ingredients in total food expenditure (de-trended) with household characteristics. The number of children is positively correlated with the cross-sectional variation in the share of ingredients, the secondary earner being in employment is negatively correlated, and both the primary and secondary earners' real wages are negatively correlated, but the secondary earner's more so.

Table 2.3: *Cross section correlation between share of ingredients in food expenditure and demographics*

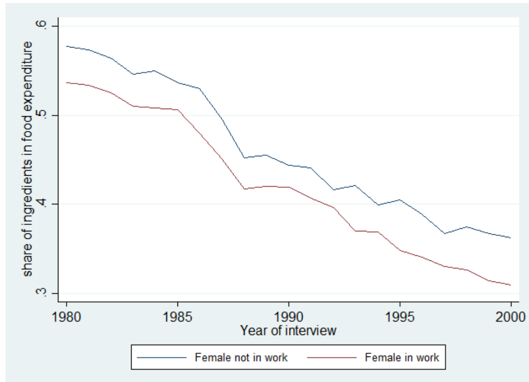
	(1)	(2)	(3)
has one child	0.00912***	0.00794**	0.00812**
	(0.00225)	(0.00258)	(0.00257)
has two children	0.00690**	0.00760**	0.00800***
	(0.00212)	(0.00239)	(0.00239)
has ≥ 3 children	0.0120***	0.0154***	0.0152***
	(0.00274)	(0.00336)	(0.00336)
female in work	-0.0400***		
	(0.00166)		
female working hours		0.000222	
		(0.000520)	
male working hours		0.000910	
		(0.000968)	
female log real wage			-0.0128***
			(0.00257)
male log real wage			-0.0280***
			(0.00256)
Observations	29602	20524	20524
Adjusted R^2	0.072	0.069	0.077

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: OLS regressions; column (1) uses the sample of households in the FES as in previous figures. Columns (2) and (3) restrict the sample to couples where the female is in work and hence has a positive wage observation. In all cases, the dependent variable is the nominal share of ingredients in the household's food expenditure minus the mean share in that year-month. For the number of dependent children, the reference group is having none. All the regressions also condition on the female's age, age squared and years of education.

Figure 2.6: *Share of ingredients in food expenditure by female employment*



Cross-sectional correlations in the 2000 Time Use Survey paint the same picture. Table 2.4 shows that individuals' time on food management is significantly negatively correlated with their own working hours. Female time on food management is also strongly increasing in the number of children. These correlations are robust to the inclusion of age, education and self-reports of how much they enjoy cooking.

Table 2.4: *Tobit regressions of weekly hours on food management on weekly working hours*

	(1) female	(2) female	(3) female	(4) male	(5) male	(6) male
model						
female in work	-4.626***			0.777*		
	(0.482)			(0.371)		
one child		0.531	1.390**		0.203	0.247
		(0.526)	(0.516)		(0.492)	(0.471)
two children		1.628**	2.549***		0.851	0.868
		(0.566)	(0.545)		(0.529)	(0.497)
$\geq$ 3 children		3.246***	4.256***		0.0404	0.0267
		(0.866)	(0.854)		(0.813)	(0.784)
male working hours		0.00273			-0.0239	
		(0.0220)			(0.0209)	
female working hours		-0.0961***			-0.00196	
		(0.0183)			(0.0172)	
male wage			-0.0726			-0.752
			(0.449)			(0.409)
female wage			-1.149**			-0.156
			(0.437)			(0.397)
Observations	687	530	530	687	530	530
Adjusted R^2						

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: The sample is working-age couples with any number of dependent children where the male is a full-time employee and both adults working hours are reported (including zero for the female). The dependent variable is the female's weekly hours on food management as main activity for the first column, and the male's for the next three columns. Columns (1) and (4) have no other regressors. Columns (2) and (5) condition on each adult's age, age squared and education. Columns (3) and (6) additionally conditions on each adult's reported taste of cooking (in five bands).

3 Structural model

We present a model of consumption and time use, with home production of food. Households consist of two adults with any number K of children (including none). Utility is derived from consuming food f, which is assumed to be private; a non-food non-durable composite good x, which exhibits some degree of publicness; and leisure l. We follow Barten (1964), Deaton and Paxson (1998) and Crossley and Lu (2018) in allowing for demographic composition to enter as price deflators. We specify a utility function corresponding to a unitary model with fixed weights:

$$\max_{f,x,l} nU(\frac{f}{n}, \frac{x}{n^\theta}, \frac{l}{n}), \tag{3.1}$$

Household size n is equal to $2 + K$, since we only consider households with 2 adults; and $\theta \in [0, 1]$ captures the returns to scale in the non food good x. If $\theta = 0$, x is entirely public, and if $\theta = 1$, there are no returns to scale in x. Leisure enters preferences as the sum of the leisure times of both adult household members, $l = l_1 + l_2$. Leisure times of both household members are assumed to be perfect substitutes in preferences because of the assumption that men working hours are constrained, so that the opportunity cost of leisure time for men is the wage of the women, and non working time is the sum of leisure time and cooking time.

Food can be cooked at home, by combining time and market bought ingredients, or purchased ready to eat, in which case it requires no processing time. Home cooked food and ready to eat food are not assumed to be perfect substitutes in preferences:

$$\frac{f}{n} = f(\frac{r}{n}, \frac{c}{n}) \tag{3.2}$$

where r is home cooked food and c is ready to eat food.

We follow Hamermesh (2008) in assuming that ingredients i and time spent cooking t are complements, so that home cooked food r is produced according to:

$$\frac{r}{n} = min[\frac{i}{n}, \frac{Bt}{n^{\gamma}}] \tag{3.3}$$

We assume that the production technology is linear homogenous in time and ingredients, but not in household size, so as to capture that a home-cooked meal for two takes less than twice the time required to prepare a meal for one. In other words, there are returns to scale in cooking which are represented by $\gamma \in [0, 1]$. If $\gamma = 0$, it takes the same time to cook a given quantity of food per capita, whatever the total quantity of food cooked, while if $\gamma = 1$, there are no returns to scale in cooking, so that it takes twice the time to cook for 2 as it takes to cook for 1. The time inputs of the adults are perfect substitutes in the production of home cooked food, $t = t_1 + t_2$. The parameter B transforms quantities into time.

Adults allocate time between market work h_s, the production of home-cooked food t_s and leisure l_s, with $s = 1, 2$ for the adult members of the household. The time constraints for both individuals are:

$$t_s + l_s + h_s = T \qquad\qquad s = 1, 2. \tag{3.4}$$

Working hours for the main earner are assumed to be constrained:

$$T - l_1 - t_1 = \overline{h}_1.$$

This assumption is justified by empirical evidence. Indeed, the elasticity of hours of work of males is low, which is usually interpreted as due to a constraint on male hours Non market time is the time not spent working for a wage, it is the sum of the time spent cooking and of leisure. Leisure is all the time which is not spent sleeping, cooking or working for a wage. Since food can be produced at home, by combining time and ingredients, there is no separability between food and time, or between food and other non-durable goods, which is why we have to model the demand for a non food non durable good (henceforth the outside good [1]).

Households purchase ready to eat food c, ingredients i and non food x, which they fund with market work and non labour income:

$$p_c c + p_i i + p_x x = y_0 + w_1 \overline{h_1} + w_2 h_2, \tag{3.5}$$

where p_k is the market price of good k, y_0 is unearned income, and w_s, $s = 1, 2$ is hourly wage for the main and the secondary earner. Households chose how much ready to eat food and home cooked food to eat, how to use time, and how much to spend on the non food good. We have written the model in terms of goods purchased: ready to eat food c, ingredients i and non food good x. We now rewrite it in terms of the objects of choice: ready to eat food c, home cooked food r, non food x and time, t and l. From the production function, we obtain the relationship between home cooked food r and ingredients i and between home cooked food r and time spent cooking t. The Leontieff assumption yields:

$$\frac{r}{n} = \frac{i}{n} = \frac{Bt}{n^{\gamma}} \tag{3.6}$$

so that:

$$i = r \qquad \text{and} \qquad t = \frac{r}{Bn^{1-\gamma}} \tag{3.7}$$

We can substitute for ingredients i and time spent cooking t in the budget constraint, expressed in terms of individual consumption. Because of the assumption that the time inputs of both household members are perfect substitutes in the production of home cooked food, there is one price for the time input t. The relevant price for the time input t is the opportunity cost of the time of the household member who is not constrained on the labour market, ie it is w_2, the wage of the woman, or secondary earner. Indeed, if the constrained individual reallocates time from cooking to leisure, for a given amount of home cooked food, then the unconstrained individual reallocates time to cooking, away

[1] The outside good includes personal goods and services as well as leisure services and leisure goods. It is assumed to have some degree of publicness.

from either market work or leisure. In other words, the price of the time input is the opportunity cost of time of the unconstrained individual, w_2. The budget constraint in terms of full time income, and individual consumption, where the time of the primary earner is valued at the wage of the secondary earner, is:

$$\left(p_i + \frac{w_2}{Bn^{1-\gamma}}\right)\frac{r}{n} + p_c\frac{c}{n} + \frac{p_x}{n^{1-\theta}}\frac{x}{n^{\theta}} + w_2\frac{l}{n} = \frac{1}{n}\left(y_0 + w_1\overline{h_1} + w_2 T + w_2(T - h_1)\right), \tag{3.8}$$

Let k^* and p_k^* respectively denote the individual quantity demanded for good k and its shadow price. The household's problem can be re-written, in terms of individual quantities demanded and shadow prices, as:

$$\begin{cases} \max_{r^*,c^*,x^*,l^*} \; nU(r^*, c^*, x^*, l^*), \\ \text{s.t } p_r^* r^* + p_c^* c^* + p_x^* x^* + p_l^* l^* = \\ \qquad\qquad \frac{1}{n}(y_0 + w_1\overline{h_1} + w_2 T + w_2(T - \overline{h_1})) \end{cases}$$

where

$$p_r^* = p_i + \tfrac{w_2}{Bn^{1-\gamma}} \qquad r^* = \tfrac{r}{n}$$

$$p_c^* = p_c \qquad c^* = \tfrac{c}{n}$$

$$p_x^* = \tfrac{p_x}{n^{1-\theta}} \qquad x^* = \tfrac{x}{n^{\theta}}$$

$$p_l^* = w_2 \qquad l^* = \tfrac{l}{n}$$

The RHS of equation (3.8) is the full income of the household. Because of the constraint on hours worked by agent 1, the non market time of agent 1 is valued at the wage of agent 2.

Even though the primary earner can adjust their use of time between leisure and cooking, the relevant opportunity cost for them is not their own wage, since they are constrained on the labour market. Indeed, in this model, a marginal increase in leisure of the primary earner, for a given level of ingredients and leisure of the secondary earner leads to a reduction in cooking time by the primary earner, an increase in cooking time by the secondary earner and a reduction in working hours of the secondary earner. In a sense, there is a tradeoff between leisure of the primary earner and working hours of the secondary earner, because the two adults can substitute their cooking times. This leads to both the shadow price of leisure of the primary earner, and the shadow price of home cooked food to depend on the wage of the secondary earner. It is worth noting also that the shadow price of home cooked food does not depend on hours worked by either adult members of the household.

We see from the expressions of the shadow prices that demands for home cooked food and for the non food good depend on household size. If cooking is more efficient in larger households, the shadow price of home-cooked food will be lower for larger households. Home-cooked food is also more expensive with higher market wages for the secondary earner. There have been significant changes over time in household size and in wages, and so these will have altered the relative shadow prices for home-cooked and ready to eat foods. These changes are a candidate explanation for movements over time in the composition of household food budgets.

We examine the predictions of the model. When household size increases, the shadow price of home cooked food and shadow price of the non food good decrease. The subsitution effect leads to an increase in the consumption of home cooked food, and of the non food good, and a decrease in the consumption of ready to eat food. The income effect goes in the same direction as the substitution effect for home cooked food and the non food good, and in the opposite direction for ready to eat food. We should see that for a given level of full time income per capita, as household size increases, the consumption of home cooked food per capita increases, the consumption of the non food good per capita increases and the consumption of ready to eat food per capita might increase or decrease. The effects of changes in wages are as follows. An increase in the wage of the secondary earner corresponds to an increase in the shadow price of home cooked food. There is a decrease in the demand for home cooked food, and an increase in the demand for ready to eat food, as per the substitution effect. The income effect goes in the same direction as the substitution effect for home cooked food and in the opposite direction for ready to eat food. There are also endowment effects, so that an increase in the wage is an increase in full time income, hence, an increase in the demand for home cooked food and ready to eat food per capita. Altogether, increases in wages may lead to increases or decreases in the demand for both home cooked food per capita and ready to eat food per capita, for a given level of full time income per capita, depending on the relative strengths of the substitution, income and endowment effects.

Note that in the presentation of the model, there are two foods entering utility: ready-to-eat food and home-cooked food. Ready-to-eat food is further divided in the empirical implementation, where we consider the choice between three types of ready to eat foods: firstly, processed food, which is bought to be eaten at home, and requires no processing time; secondly, restaurant meals, and finally, take-aways and snacks. If we wanted to be entirely precise we would allow for the fact that food eaten in restaurants takes time, and we would allow for a different production function to that of food produced at home. Abstracting from this potentially introduces a mis-specification in the model, however, we think this will be small. The share of restaurants is small compared to those of ingredients for home cooking and of processed foods, and the time spent in restaurants could also be considered as leisure, which brings yet another level of complexity to the modelling of choices. The price of a restaurant meal also includes the opportunity cost of time of the employees of the restaurant. We chose to abstract from these refinements in the specifications, which we think are likely to be second order importance. We are also guided by data considerations: as we have mentioned, while the data on expenditure on ingredients and processed food is of sufficient quality, that on meals taken out of the home is of poor quality.

4 Empirical implementation

We take the structural model to data for the UK from 1980 to 2000. We use data from the UK Family Expenditure Survey (FES), which is a nationally-representative, repeated cross sections. The FES contains detailed information on expenditure, socio-demographic information, labour supply (participation and hours worked) and incomes. We use data on households with two adults and a working head of household between 25 and 64 years old and with any number of children (including zero). Our sample includes 38,291 observations on between 53 and 314 households per month. See Appendix A for further details on the data.

We specify a functional form for the demand system, which requires us to group foods, calculate full time income and construct price indices. We group foods by time use and construct a price index for each commodity aggregate. We use prices from the ONS RPI series.

For households with both adults in employment, we can calculate full income, and shadow prices from observed data. The shadow price of home cooked food depends on the returns to scale parameter γ, which is calibrated. For households in which the second earner is not in employment, we do not observe the wage, and so cannot construct full income or shadow prices. In order to calculate full time income we estimate a participation model that allows us to correct for selection in the estimation of the demand system. We then estimate the demand system on the sample of two-earner households, including the selection correction.

4.1 Functional form for the demand system

We assume the demand system takes the form of Almost Ideal demand system (Deaton and Muellbauer (1980)) with six goods - home cooked food, processed food, meals-out, snacks, non-food non-durables and leisure. See Appendix A.1 for details.

The share of good j in full income is a linear function of log shadow prices of all five goods and log real full income.

$$
\begin{aligned}
w_j =&\alpha_j + \delta_{jr} \ln p_r^* + \delta_{jc} \ln p_c^* + \delta_{jm} \ln p_m^* + \delta_{js} \ln p_s^* + \delta_{jl} \ln p_l^* + \delta_{jx} \ln p_x^* + \beta_j ln(\frac{Y}{P}) \qquad (4.1)\\
&j \in \{r, c, m, s, x, l\}
\end{aligned}
$$

where

- subscripts $\{r, c, m, s, x, l\}$ stand for home cooked food, processed food, meals-out, snacks,non-food non-durables and leisure.
- P is the usual AIDS deflator (which depends on parameters)
- for each j, α_j includes a constant and linear controls of: age of the woman, her age squared, her years of education, whether there are children, age of the youngest child, and monthly dummies.

Returns to scale in cooking are represented by the parameter γ, which we set to 0.5.

Full income Y is total resources available for spending on non-durables as well as leisure. Note that, because we assume that the market hours of the primary earner are constrained and that the household production function for home-cooked food is Leontieff in the sum of the times spent cooking and the ingredients, full income equals $y_0 + w_1\overline{h_1} + w_2T + w_2(T - \overline{h_1})$. In principle we could use this expression to measure full income, however, we do not have good data on unearned income, y_0. Unearned income is often negative in the FES, and we have not incorporated saving or borrowing in this model. Instead we measure full time income using total weekly expenditure on all items (food plus non food x) plus the imputed cost of time spent cooking and on leisure $w_2(2T - \overline{h_1} - h_2)$.

As we impose price homogeneity, (4.1) can expressed as

$$w_j = \alpha_j + \delta_{jr} \ln \frac{p_r^*}{p_x} + \delta_{jc} \ln \frac{p_c}{p_x} + \delta_{jm} \ln \frac{p_m}{p_x} + \delta_{js} \ln \frac{p_s}{p_x} + \delta_{jl} \ln \frac{w_2}{p_x} + (1-\theta)\delta_{jx} ln(n) + \beta_j ln(\frac{Y}{P}) \tag{4.2}$$

$$j \in \{r, c, m, s, x, l\}$$

When taking (4.2) to the data, we correct for selection (as explained in the next subsection). Because the shares necessarily add up to 1, we estimate the share equation for the food categories and leisure only. We also impose symmetry.

4.2 Labour Market Participation and Wages of the Secondary Earner

We observe the wage of all primary earners. For secondary earners some participate in the labour market, in which case we observe their wage, and others do not participate. We use data on all secondary earners to estimate participation status and a wage equation. This allows us to compute an inverse Mills ratio for all secondary earners. The inverse Mills ratio is used to correct for selection in the estimation of the structural model of demand and time use.

Each individual has a potential wage, W_i^p, if they participate in the labour market, that is given by:

$$\ln W_i^p = X_i\theta + Q_i\delta + u_i, \tag{4.3}$$

and a reservation wage, W_i^r, that dictates whether they participate, given by:

$$\ln W_i^r = X_i\alpha + Zi\beta + \varepsilon_i, \tag{4.4}$$

where

$$\begin{pmatrix} u \\ \varepsilon \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_u^2 & \rho\sigma_u\sigma_\varepsilon \\ \rho\sigma_u\sigma_\varepsilon & \sigma_\epsilon^2 \end{pmatrix}\right].$$

X_{it} includes age and age squared and a year dummy. Q_{it} includes education (measured by the age at which the individual exited education) and the region of residence (to control for local labour market conditions). Z_{it} contains whether there are children present in the household, the number of children (with separate effects for the number of children under 5 years of age, and the number of children between 5 and 11 years old), the household's unearned income, and the wage, hours of work and occupation of the primary earner.

The secondary earner chooses to participate in the labour market if their potential wage is greater than their reservation wage:

$$u_i - \varepsilon_i > X_i(\alpha - \theta) - Q_i\delta + Zi\beta.$$

We observe the wage, W_i, which is given by

$$W_i = \begin{cases} W_i^p & \text{if} \quad u_i - \varepsilon_i > X_i(\alpha - \theta) - Q_i\delta + Zi\beta \\ 0 & otherwise \end{cases}$$

We estimate the wage equation to obtain the estimate coefficients $\widehat{\theta}$, $\widehat{\delta}$, and $\widehat{\rho\sigma_u}$. In a Probit, the scale of the parameters is not identified: we obtain $k\widehat{(\alpha - \theta)}$, $\widehat{k\delta}$, and $\widehat{k\beta}$, where $k = 1/\sigma_{u-\varepsilon}$ is unknown.

In theory $\widehat{\delta}$ and $\widehat{k\delta}$ are two estimates of the same vector δ, except for the scale transformation k. We can use them to retrieve $\widehat{k}$ and another (better) estimate of δ. Specifically, we solve the following problem

$$\min_{k,\delta} \left((\widehat{\delta} - \delta)', (\widehat{k\delta} - k\delta)' \right) \sum{}^{-1} \begin{pmatrix} \widehat{\delta} - \delta \\ \widehat{k\delta} - k\delta \end{pmatrix}$$

where $\sum$ is the covariance matrix of $\begin{pmatrix} \widehat{\delta} - \delta \\ \widehat{k\delta} - k\delta \end{pmatrix}$

We approximate $\sum$ by the estimated variance covariance matrix corresponding to $\widehat{\delta}$ and $\widehat{k\delta}$.

The inverse of $\hat{k}$ is $\widehat{\sigma_{u-e}}$. We obtain $\widehat{\alpha}$ as $\widehat{\theta} - k\widehat{(\alpha - \theta)}/\hat{k}$, and $\widehat{\beta}$ as $\widehat{k\beta}/\hat{k}$

We compute $\widehat{\zeta_i} = X_i(\widehat{\alpha} - \widehat{\theta}) - Q_i\widetilde{\delta} + Z_i\widehat{\beta}$. The probability of participation for each individual as $\Phi(-\widehat{\zeta}_i/\widehat{\sigma_{u-e}})$ and the Inverse Mills Ratio is $[\phi(-\widehat{\zeta}_i/\widehat{\sigma_{u-e}})/\Phi(-\widehat{\zeta}_i/\widehat{\sigma_{u-e}})]$.

Table 4.1: *Heckman wage equation*

Ln wage secondary earner	
Age spouse left school	0.076
	(0.001)
Age secondary earner	0.023
	(0.002)
Age secondary earner squared	-0.000
	(0.000)
Constant	-1.357
	(0.049)
select	
Age spouse left school	0.054
	(0.004)
Age secondary earner	0.110
	(0.009)
Age secondary earner squared	-0.002
	(0.000)
Any children	-1.551
	(0.042)
Number of children	-0.044
	(0.013)
Child under 5	0.137
	(0.077)
Child 5-11	0.365
	(0.048)
Ln unearned income	-0.146
	(0.007)
Unearned income missing	-0.112
	(0.059)
Age youngest child	0.129
	(0.006)
Ln wages head	-0.500
	(0.028)
Head professional	0.038
	(0.032)
Head skilled	0.033
	(0.025)
Head white collar	0.120
	(0.028)
Hours work head	-0.012
	(0.001)
Constant	-0.479
	(0.209)
mills	
lambda	0.064
	(0.009)
N	29456

Notes: Both regressions include 12 region dummies.

The selection equation results are not surprising: the probability to participate is increasing in the education of the secondary earner, decreasing in unearned income, the male's wage and hours of work. It is also lower for females who have children and increasing in the age of the youngest child. The potential wage is increasing in the education of the secondary earner, the age of the secondary earner until about 50 years of age and decreasing afterwards.

Figures 4.1 shows the predicted wage against the actual wage through time for participants. We see that we are able to reproduce the time paths of the wages between 1980 and 2000.

Figure 4.1: *Actual and predicted ln wage of secondary earner*

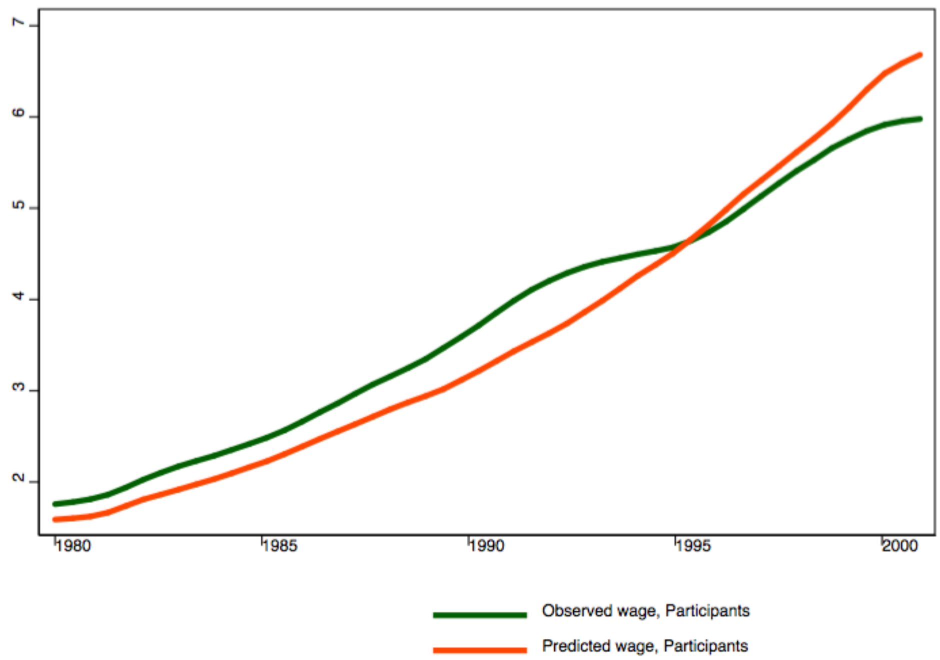
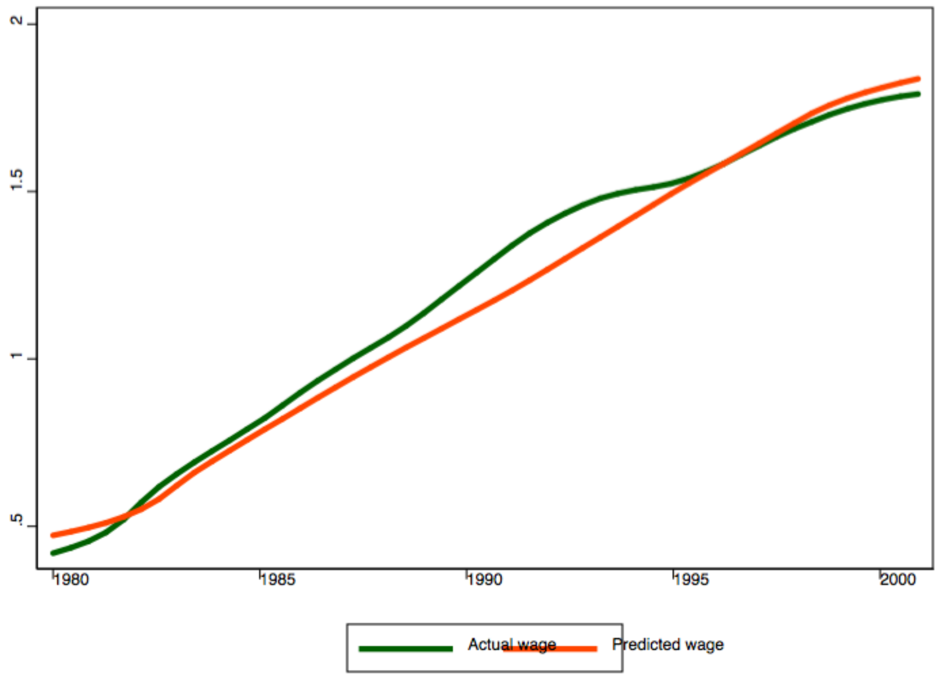


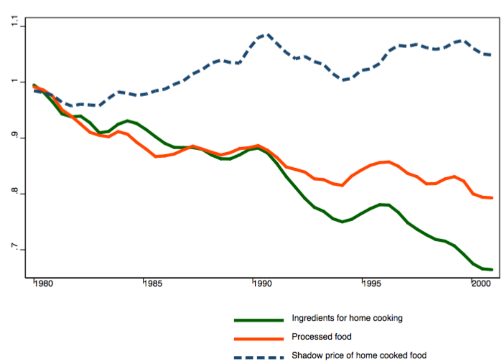
Figure 4.2: *Actual and predicted ln wage of secondary earner - Participants only*



4.3 Shadow price of home-cooked food

The shadow price of home cooked food is given by $p_r^* = p_i + \frac{w_2}{Bn^{1-\gamma}}$. Setting γ to 0.5, we can construct the shadow price of home cooked food. We show its time path, together with those of the prices of ingredients and of processed foods in figure 4.3.

Figure 4.3: *Prices of ingredients and processed food, and shadow price of home-cooked food*



Note:All relative to the price of the outside good.

Wages have grown whilst the prices of foods have decreased, and since cooking takes time, the shadow price of home-cooked food, which incorporates the opportunity cost of time, has in fact increased over the period, as is shown in figure 4.3.

5 Estimates and fit of the model

We first present income and price elasticities constructed from the demand estimates, then Engel curves and we compare the actual and predicted time trends of the food shares. The coefficient estimates of the structural model, and for comparison a standard demand model (omitting leisure) are shown in Appendix **??**. We also examine the performance of the labour force participation and wages part of the model. Finally, we discuss the shadow price of home cooked food as a function of predicted wages.

5.1 Price and income elasticities

We compute income and price elasticities for the demand system with time use, imposing symmetry. The price elasticities are with respect to the effective prices of the goods, which in the case of home cooked food is the shadow price.

Starting with the income elasticities, home cooked food, processed food and take away and snacks are necessities, and their income elasticities are very similar. Restaurant meals are a luxury. Food altogether is usually found to be a necessity and this would be the case here.

Turning to the price elasticities, own price elasticities are negative and significant for all foods, with processed food and restaurant the most price elastic, and home cooked food the least price elastic.

Cross price elasticities are often difficult to estimate, particularly when they concern goods for which there is limited relative price variation. Here, all the Marshallian cross price elasticities are significantly different from zero, apart from the elasticity of the quantity demanded of processed food to the price of take away. Several of the compensated elasticities are zero: that of the demand for processed food to the price of home cooked food; those of home cooked food and take away to the price of processed food; and those of home cooked food processed food to the price of take away. In these cases, the income effect drives the quantity response. The cross price elasticity of the demand for processed foods to the price of home cooked food is negative, suggesting that home cooked food and processed foods are complements. However, since their compensated cross price elasticity is zero, the negative sign indicates only that they are normal goods. At any rate, we would not necessarily expect home cooked food and processed food to be substitutes, since the former requires time., so that the negative relationship might capture the lack of substituability between food and leisure. The cross price elasticity of restaurant meals to the price of home cooked food is also negative and significant, indicating that restaurants and ingredients are complements. Here the substitution effect dominates the income effect, suggesting that this is an effect of the opportunity cost of time. This result can be interpreted as suggesting that when time is more expensive, there is less time to either cook or go to restaurants. It is plausible that there is not much substituability between leisure and food. Finally, take away and snacks are found to be substitutes to home cooked food, which can be rationalised again with an opportunity cost of time argument.

The non food non durable aggregate is constituted of expenditures on a heterogenous group of goods, including tobacco, alcohol, expenditure on leisure goods. The heterogenous nature of the composite means that the elasticities cannot be easily interpreted. This argument also applies to the leisure good.

Table 5.1: *Marshallian elasticities*

		Price					
	Income	Home cooked fd	Processed fd	Restaurant	Take Away	Non-fd	Leisure
Home fd	0.50	-0.70	-0.07	-0.35	0.08	0.43	0.10
	0.01	0.06	0.03	0.03	0.02	0.05	0.04
Proc.fd	0.61	-0.21	-3.39	2.14	-0.19	1.25	-0.22
	0.02	0.09	0.11	0.12	0.14	0.16	0.06
Restaurant	1.99	-3.53	7.03	-3.66	3.61	-6.48	1.04
	0.07	0.26	0.39	0.55	0.45	0.45	0.15
Take away	0.63	0.50	-0.45	2.58	-1.10	-1.71	-0.46
	0.05	0.16	0.33	0.32	0.29	0.31	0.09
Non-food	2.06	0.07	0.22	-0.47	-0.20	-0.42	-1.27
	0.01	0.04	0.04	0.03	0.03	0.06	0.03
Leisure	0.76	-0.01	-0.03	0.05	-0.02	-0.20	-0.55
	0.01	0.01	0.01	0.00	0.00	0.01	0.01

Note:

Table 5.2: *Hicksian elasticities*

		Price					
	Income	Home cooked fd	Processed fd	Restaurant	Take Away	Non-fd	Leisure
Home fd	0.50	-0.63	-0.04	-0.34	0.09	0.54	0.38
	0.01	0.06	0.03	0.03	0.02	0.05	0.04
Proc.fd	0.61	-0.12	-3.36	2.15	-0.18	1.38	0.13
	0.02	0.09	0.11	0.12	0.14	0.16	0.06
Restaurant	1.99	-3.25	7.13	-3.63	3.65	-6.07	2.16
	0.07	0.26	0.39	0.55	0.45	0.45	0.15
Take away	0.63	0.59	-0.42	2.59	-1.09	-1.58	-0.10
	0.05	0.16	0.33	0.32	0.29	0.31	0.10
Non-food	2.06	0.37	0.33	-0.43	-0.16	0.01	-0.11
	0.01	0.04	0.04	0.03	0.03	0.06	0.02
Leisure	0.76	0.10	0.01	0.06	-0.00	-0.04	-0.12
	0.01	0.01	0.01	0.00	0.00	0.01	0.01

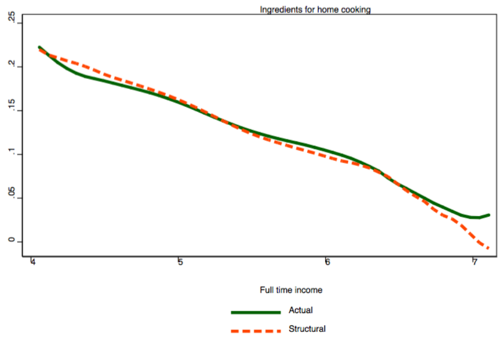
Note:

5.2 Fit of the structural model

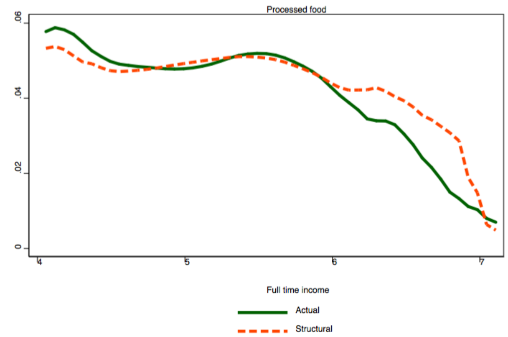
In figure 5.1, we show the Engel curve derived from the structural model, together with the relationship between the shares and full time income. For ingredients, processed food and take away and snacks, the Engel curves confirm the conclusions drawn from the income elasticities: all three foods are necessities. Restaurant meals only become a luxury at high level of full time income.

Figure 5.1: *Engel curves from structural model*

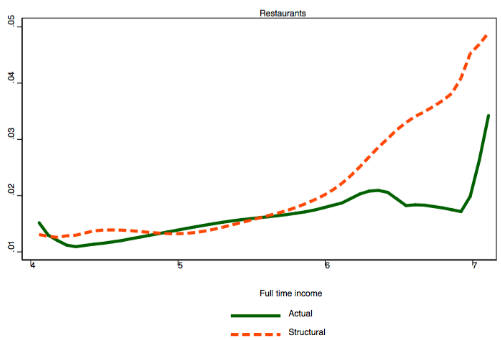
(a) Ingredients



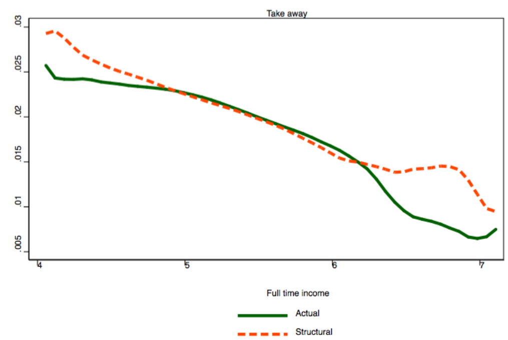
(b) Processed



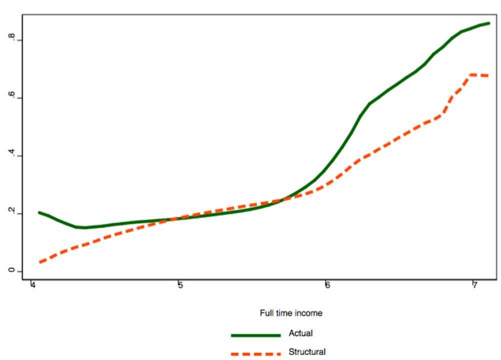
(c) Restaurant



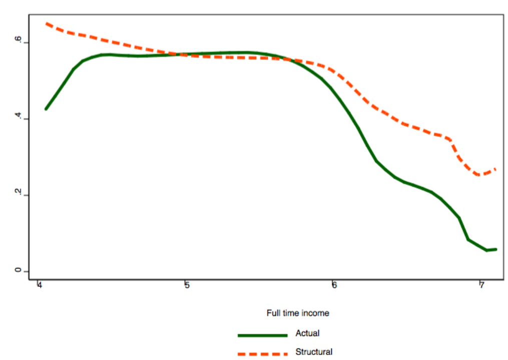
(d) Take away and snacks



(e) Non-food



(f) Leisure

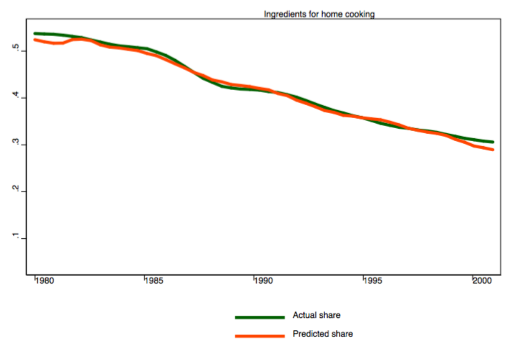


Note:.

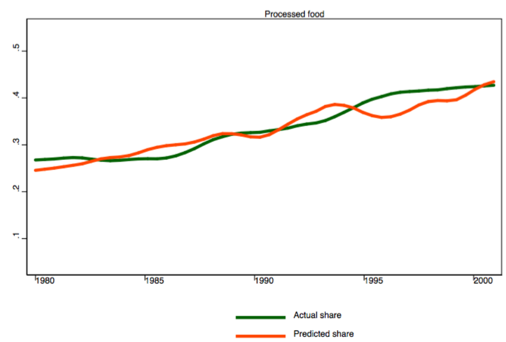
We also assess the fit of the structural model by comparing the actual and predicted shares of foods over the period 1980 to 2000, shown in figure 5.2. The model is estimated in terms of shares out of total expenditure on non durables, and the predictions are then re-scaled to be out of food expenditure. The model does very well in terms of capturing the trends of expenditures on the different food aggregates, particularly ingredients, pre-prepared food and meals out. For reasons we explained above regarding the collection of data on take away and snacks, the quality of the data on these foods is lower. Because of these issues, the raw time trend of the budget share for "Take away and snacks" is probably mostly due to data collection issues, and unsurprisingly, not only is there not much of a trend in the share of this good, but the model does quite poorly in predicting the evolution of the share of expenditure on this composite food.

Figure 5.2: *Actual and predicted shares of food*

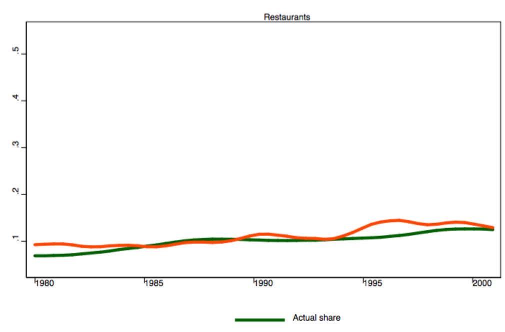
(a) Ingredients for home cooking



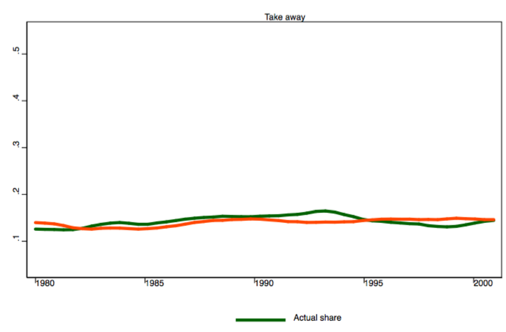
(b) Pre-prepared food



(c) Meals out



(d) Take away and snacks



5.3 Shadow price of home cooked food at predicted wage

Using the estimates we obtain for labour force participation and wages, we construct a reservation wage and a potential wage for each individual. To measure the opportunity cost of time, we use the observed wage for participants, and the reservation wage for non participants. Over the period 1980-2000, nominal reservation wages have increased less than the price of the outside good, so that real reservation wages have decreased.

The predicted shadow prices of home cooked food, together with the price of ingredients for home cooking and the price of processed foods are in figure 5.3. The shadow price of home cooked food is lower for non participants than for participants. For the latter, not only the opportunity cost of time is greater, but also household size is on average smaller. All these effects combine to yield a higher shadow price of home-cooked food for participants than for non participants.

Figure 5.3: *Shadow price of home cooked food at predicted wages*
Participants and non participants

6 Effect of a counterfactual tax on processed food

We run price counterfactuals, with different levels of tax on the price of processed foods.

We do not run a wage counterfactual. Our model is static, and a wage counterfactual would require a dynamic model. Indeed, it has been documented that when real wages decrease, people dont change their labour supply. This is because there is a wealth effect which operates along the substitution effect. Another reason to consider the effect of a tax on food rather than of a tax on time is that price is a more plausible policy lever than wages.

We focus on the effect of a tax on the consumption of ingredients for home cooking, processed food and meals out. For the reasons detailed above, we do not focus on the effect on Take away and snacks.

We run three counterfactuals where processed food is taxed at 10% and 20%, and 40% respectively.

Figure 6.1: *Effect of a 10% tax on processed food*

(a) Ingredients (b) Pre-prepared (c) Restaurant

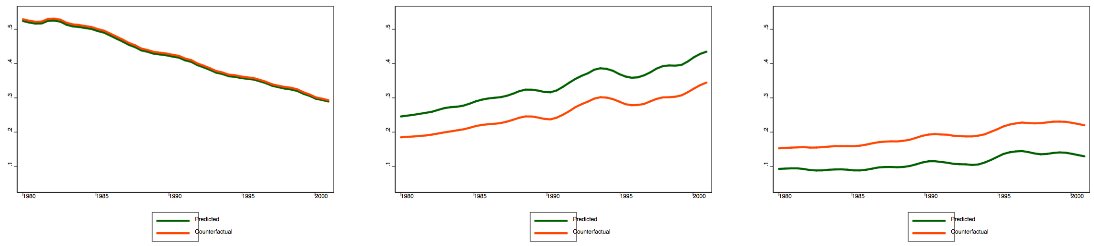


Figure 6.2: *Effect of a 20% tax on processed food*

(a) Ingredients (b) Pre-prepared (c) Restaurant

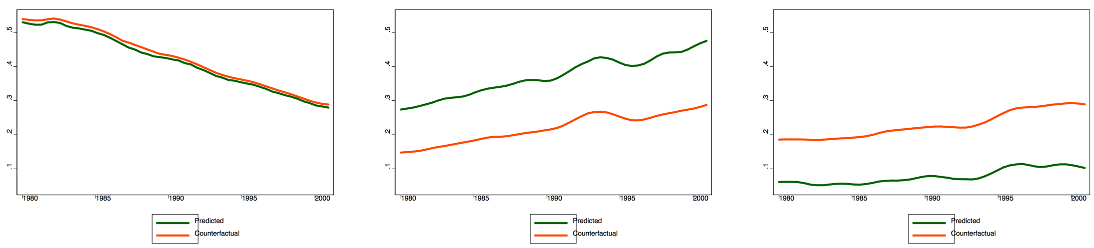
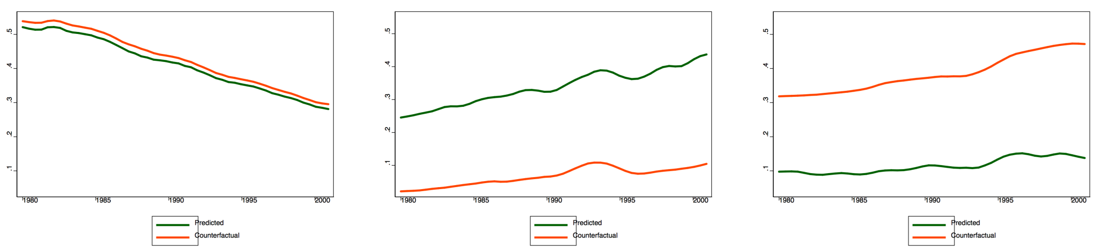


Figure 6.3: *Effect of a 40% tax on processed food*

(a) Ingredients (b) Pre-prepared (c) Restaurant



Note: Participants

According to our counterfactual analysis, the effect of the tax on processed is to make households substitute restaurant meals for processed food. There is no significant effect of the counterfactual tax on ingredients for home cooking.

7 Conclusions

There has been a significant decline in the share of ingredients in UK households' food expenditure in the past thirty years. This has happened despite a long-term fall in the price of ingredients relative to processed food. The key to understanding this phenomenon is to recognize that the true cost of ingredients includes the opportunity cost of cooking time. which has increased rapidly due to wage growth.

We have developed a theoretical consumption model that explicitly allows time cost in the home production of food. We estimate a set of expenditure share equations that are derived directly from the model. This approach gives predictions of time trends that are similar to the observed. We found that the fall in the price of processed food relative to non-food is important in explaining the long-term shift of consumption away from ingredients and towards processed food. Our analysis shows that, as the shadow price of home cooked food depends so much on the wage, taxes on market prices unlikely to provide incentives for households to switch away from ready to eat food and consume more home cooked food. This discussion has been largely missing from the policy debates around these questions. There are other relevant aspects of the choices of use of time and food. For instance, what do parents do when they are not cooking? How much of the time saved by not cooking is allocated to investment in the human capital of their children?

A Data

The data used in this publication were made available through the ESRC Data Archive. Data from the Family Expenditure Survey, Expenditure and Food Survey and Living Costs and Food Survey is Crown Copyright and reproduced with the permission of the Controller of HMSO and the Queens Printer for Scotland. Neither the original collectors of the data nor the Archive bear any responsibility for the analyses or interpretations presented here.

The references for these datasets are:

- Family Expenditure Survey; Department of Employment. (1993). Family Expenditure Survey, 1980. [data collection]. UK Data Service. SN: 3057, http://dx.doi.org/10.5255/UKDA-SN-3057-1; and all following years until 2000.

- Expenditure and Food Survey; Office for National Statistics, Department for Environment, Food and Rural Affairs. (2007). Expenditure and Food Survey, 2001-2002. [data collection]. 3rd Edition. UK Data Service. SN: 4697, http://dx.doi.org/10.5255/UKDA-SN-4697-1; and all following years until 2007.

- Living Costs and Food Survey; Office for National Statistics and Department for Environment, Food and Rural Affairs, Living Costs and Food Survey, 2008 [computer file]. Colch-

ester, Essex: UK Data Archive [distributor], March 2010. SN: 6385.http://dx.doi.org/10.5255/UKDA-SN-6385-1; and all following years until 2013.

Apart from the prices, the data is a series of repeated cross sections of the UK Family Expenditure Survey, from 1980 to 2000. We extract a sample of households with or without children in which the head of household is between 25 and 64 years old. There are approximately 200 households per month, giving us a total of 45000 observations. The survey contains detailed information on expenditure on food and non-food non-durable expenditures, as well as socio-demographic information. There is also information on labour supply (participation and hours worked) and incomes.

The price data consists in about 30 series of price indices obtained from the ONS.

A.1 Food groups

Category	Description	Price index (RPI categories)
1. Ingredients		
Ingredients for cooking	Meat, eggs, fish, vegetables, butter, margarine, pasta, rice, legumes, oil, flour	beef, lamb, pork, bacon, poultry, oth_meat, fish, butter, oil_fats, eggs, pots, oth_vegs
Ingredients (also ready-to-eat)	Bread, cheese, cold and cooked meats cream, milk, yoghurt, fruit, juice, prepared fish	bread, cheese, fruit, milkprod, milkfres beef, lamb, pork, bacon, poultry, oth_meat, fish
2. Processed		
Drinks	Carbonated drinks, coffee, tea, hot choc, fruit juice, squash, bottled water	softdrin, tea, coffee
Ready meals	Ready meals, packaged and canned foods, breakfast cereals, pickles, sauces, soup, baby food	oth_food, cereals
3. Food out		
Takeway (eaten at home)	Take-away meals, sandwiches	takeaway
Meals out	Meals out, inc hot, cold and canteen, snacks eaten out, workplace meals	canteen, restaur
Sweets, snacks	Confectionary, ice cream, biscuits, cakes	biscuits, sug_pres, swe_choc
4. Non-food non-durables	Alcohol, tobacco, household services, personal goods and services, leisure goods and services	Alcohol, tobacco, household services, personal goods and services, leisure goods and services

A.2 Price indices

The shadow price of home-cooked food is the price per unit of home-cooked food. For clarity of exposition, let us call this unit a meal. The cost of a meal is thus the sum of the cost of the ingredients used to cook the meal and the cost of the time spent cooking the meal. The cost of the ingredients is the product of the quantity of ingredients by the price per unit of ingredient. Because we are talking about a composite good, ingredients, the price of this good is an index. The cost of the time spent cooking a meal is much more straightforward, it is the product of the time spent cooking by the wage.

References

Altonji, J. G. and R. M. Blank (1999). Chapter 48 Race and gender in the labor market. In *Handbook of Labor Economics*, Volume 3, pp. 3143–3259. Elsevier.

Anderson, P., K. Butcher, and P. Levine (2003a, January). Economic Perspectives on Childhood Obesity. *Economics Faculty Scholarship*.

Anderson, P. M., K. F. Butcher, and P. B. Levine (2003b). Maternal employment and overweight children. *Journal of Health Economics 22*(3), 477–504.

Baum, C. L. and S. Y. Chou (2011). The Socio-economic Causes of Obesity. *NBER Working Paper*, 1–47.

Becker, G. S. (1965). A Theory of the Allocation of Time. *Economic Journal 75*, 493–517.

Bhattacharya, J. and N. Sood (2011). Who pays for obesity? *Journal of Economic Perspectives 25*(1), 139–158.

Bianchi, S., M. Milkie, L. Sayer, and J. Robinson (2000, September). Is Anyone Doing the Housework? Trends in the Gender Division of Household Labor. *Social Forces 79*(1), 191–228.

Bleich, S., D. Clutler, C. Murray, and A. Adams (2008). Why is the developed world so obese? *Annual Review of Public Health 29*, 273–295.

Blow, L., V. Lechene, and P. Levell (2014, July). Using the CE to Model Household Demand. *NBER*, 141–178.

Browning, M. and C. Meghir (1991, July). The Effects of Male and Female Labor Supply on Commodity Demands. *Econometrica 59*(4), 925.

Brunello, G., P. C. Michaud, and A. Sanz-de Galdeano (2009). The rise of obesity in Europe: An economic perspective. *Economic Policy 24*(59), 553–596.

Case, A., D. Lubotsky, and C. Paxson (2002). Economic status and health in childhood: The origins of the gradient. *The American Economic Review 92*(5), 1308–1334.

Cawley, J. (2000, August). Body Weight and Women's Labor Market Outcomes. Working Paper 7841, National Bureau of Economic Research.

Costa, D. L. (2000, December). From Mill Town to Board Room: The Rise of Women's Paid Labor. *Journal of Economic Perspectives 14*(4), 101–122.

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.

Deaton, A. and J. Muellbauer (1980). An almost ideal demand system. *The American economic review 70*(3), 312–326.

Dobbs, R., S. Sawers, F. Thompson, J. Manyika, J. Woetzel, P. Child, S. McKenna, and A. Spatharou (2014). Overcoming obesity: An initial economic analysis.

Finkelstein, E. and L. Zuckerman (2008, January). *Wiley: The Fattening of America: How The Economy Makes Us Fat, If It Matters, and What To Do About It - Eric A. Finkelstein, Laurie Zuckerman*. Wiley, New York.

Goldman, D., D. Lakdawalla, and Y. Zheng (2009). Food prices and the dynamics of body weight. Technical report, National Bureau of Economic Research.

Gomis-Porqueras, P., O. Mitnik, A. Peralta-Alva, and M. D. Schmeiser (2011, October). The Effects of Female Labor Force Participation on Obesity. *IZA Discussion Paper 6071*.

Gortmaker, S. L., B. A. Swinburn, D. Levy, R. Carter, P. L. Mabry, D. T. Finegood, T. Huang, T. Marsh, and M. L. Moodie (2011). Changing the future of obesity: Science, policy, and action. *The Lancet 378*(9793), 838–847.

Hamermesh, D. S. (2008). Direct estimates of household production. *Economics Letters 98*(1), 31–34.

Heckman, J. J. (2007). The economics, technology, and neuroscience of human capability formation. *Proceedings of the National Academy of Sciences of the United States of America 104*(33), 13250–13255.

Herbst, C. and E. Tekin (2011). Child care subsidies and childhood obesity. *Review of Economics of the Household 9*(3), 349–378.

Lakdawalla, D. and T. Philipson (2007). Labor Supply and Weight. *The Journal of Human Resources 42*(1), 85–116.

Lakdawalla, D. and T. Philipson (2009, December). The growth of obesity and technological change. *Economics & Human Biology 7*(3), 283–293.

Lakdawalla, D., T. Philipson, and J. Bhattacharya (2005). Welfare-enhancing thenological change and the growth of obesity. *American Economic Review 95*, 253–257.

Lu, Y. and D. Goldman (2010, February). The Effects of Relative Food Prices on Obesity – Evidence from China: 1991-2006. Working Paper 15720, National Bureau of Economic Research.

Mackenbach, J. P., I. Stirbu, A.-J. R. Roskam, M. M. Schaap, G. Menvielle, M. Leinsalu, and A. E. Kunst (2008, June). Socioeconomic Inequalities in Health in 22 European Countries. *New England Journal of Medicine 358*(23), 2468–2481.

Philipson, T. and R. Posner (2008). Is the Obesity Epidemic a Public Health Problem ? a Decade of. *NBER Working Paper* (May).

Philipson, T. J. and R. A. Posner (2003, July). The Long-Run Growth in Obesity as a Function of Technological Change. *Perspectives in Biology and Medicine 46*(3), S87–S107.

Smith, L. P., S. W. Ng, and B. M. Popkin (2013, April). Trends in US home food preparation and consumption: Analysis of national nutrition surveys and time use studies from 1965-1966 to 2007-2008. *Nutrition Journal 12*, 45.

Swinburn, B., G. Sacks, and E. Ravussin (2009, December). Increased food energy supply is more than sufficient to explain the US epidemic of obesity. *The American Journal of Clinical Nutrition*, ajcn.28595.