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GROSSING UP FAMILY EXPENDITURE SURVEY DATA FOR USE IN NATIONAL ACCOUNTS

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*This paper was written whilst Steve Webb was Professor of Social Policy at the University of Bath and Research Fellow at the Institute for Fiscal Studies.

EXECUTIVE SUMMARY

In this paper we show how estimates of aggregate spending in the UK would be affected by using grossing weights that take account of the known dimensions of non-representativeness of the Family Expenditure Survey. Currently a uniform weighting scheme is used by the ONS. Having estimated a model of spending at different degrees of disaggregation, corresponding to the commodities of interest as far as ONS totals are concerned, we show which dimensions of non-response are most significant in determining spending patterns. We derive five sets of grossing weights which control for combinations of these factors. We show the effects of these different grossing factors for commodity groups and for the goods for which the FES is the sole source of information in the National Accounts. The effects vary, but for some of these goods (for example, theatres and taxis) controlling for non-response in computing population aggregates could increase estimates of total spending by almost nine per cent.

Introduction

This paper considers how information from the Family Expenditure Survey (FES) on household spending can be used to obtain estimates of population spending totals for use in the National Accounts. The FES is an annual survey covering approximately 7,000 households each year — a response rate of approximately 70 per cent of the households initially sampled. All individuals in each household (including juveniles, from 1995/6 onwards) are asked to keep spending diaries for a two week period. In addition, in interview, household members are asked about regular, but infrequent expenditure items such as payment of utility bills, television licences and insurance payments. Finally, individuals are asked to recall over a longer period - typically three to six months - spending on 'bulky' items, such as furniture, holidays and vehicles. In the FES records, this information on spending is aggregated to the household level and average weekly household spending figures are derived for more than three hundred individual goods and services. Additional detailed information is available on household demographic characteristics and sources of income.

Information on expenditure in the FES is currently used to obtain estimates of national spending totals for thirty individual goods and services. On average, this represents approximately 28 per cent of total consumers' expenditure, although these expenditures are distributed unevenly across National Accounts commodity groupings. For example, estimates of spending on food, fuel, tobacco, alcohol, clothing, and energy in the National Accounts are based exclusively on non-FES sources of data. Correspondingly, the FES forms a relatively higher proportion of the estimates of spending on household goods and services, transport and communications, recreation and entertainment and other goods and services. However, even where estimates of population spending totals are derived exclusively from non-FES sources, the FES data can be used as an important check on the other estimates.

Estimating National Accounts figures from survey data such as the FES necessitates the use of grossing factors to multiply the spending of the relatively small sample of households in the survey to achieve spending totals for the whole population. The current methodology used to obtain National Accounts estimates from FES data is to multiply the spending of each household surveyed by the ratio of the number of households in the population to the number of households in the survey - a method known as uniform grossing-up. However, this method implicitly assumes that the households who respond to the FES are representative of the households in the UK. If expenditure patterns vary systematically by household type, uniform grossing factors will only achieve unbiased estimates of the population spending totals if all types of households are represented in the sample in the same proportions as in the population. Alternatively, if different households are systematically under- or over-represented in the sample relative to their proportions in the population, uniform grossing factors will only produce unbiased population totals if spending patterns do not vary systematically by household type. It is, however, relatively easy to think of cases where these conditions do not hold. For example, households with children are known to be over-represented in the FES relative to the UK population (see Kemsley, Redpath and Holmes, 1980). It is also likely that households with children will tend to have different spending patterns than households without — higher spending on children's clothing is an obvious example. In this case, uniform grossing factors will tend to over-estimate total population spending on children's clothing relative to the 'true' level.

To correct for the problem of differential response rates, each household can be assigned a different weight in the grossing up process to correct for their over- or under-representation in the sample. In this paper we estimate a set of differential grossing factors which can be used to estimate UK spending totals from FES data. These differential grossing factors take account both of the systematic variation in FES response rates across different

household types and of the systematic variation in spending patterns across different households.

There is, however, a further problem in using household survey data such as the FES to estimate National Accounts spending totals. By design, the FES excludes the UK non-household population - residents of institutions such as boarding houses, college halls of residence and army barracks, for example. In the absence of direct information on the spending of the non-household population, one suitable approach may be to make inferences from the observed spending behaviour of similar households in the FES on the basis of additional information about the incomes and demographic characteristics of institutional residents. However, this implicitly assumes that the household and non-household populations share the same preferences over goods, an assumption which, though necessary, may not always be appropriate. This and other imputations for the non-household sector are discussed.

The plan of the paper is as follows. In the next section we compare the demographic composition of the FES sample against other sources of information. In particular, we focus on the results of the OPCS non-respondent survey which used information from the 1991 census to create a demographic profile of the FES non-respondents in that year (Foster, 1996). Having determined the main dimensions in which the FES sample is unrepresentative we use an econometric model of spending patterns in cross-sectional data to determine which of these dimensions drive differences in spending patterns, looking first at all goods and services in the FES and then, in more detail, at the group of goods and services for which the FES is used to estimate National Accounts spending totals. At all stages in constructing grossing factors for this project we will use data from the 1991 FES to ensure total compatibility with the census control totals and the FES non-response study. We compare estimates of aggregate spending — using both uniform grossing factors and also weighted grossing factors computed in a number of ways.

I Comparing the 1991 FES sample with the 1991 UK Population

There are two ways in which survey data may not be representative of the population as a whole. First, some types of economic agents who fall within the sample frame may be less likely to respond to the survey or complete the questionnaire than others, leading to the average demographic structure of the respondents being different to that of the total population that lie within the sample frame. Second, some economic agents may be intentionally excluded altogether from the sample frame from which the survey is collected and if their characteristics or behaviour are different from that of the agents within the sample frame then imputing population totals for activities in which these agents participate (such as spending) will need to make allowances for these differences. The way in which we deal with these issues is described below.

a) Non-response

In an important study reported in *Statistical Monthly Bulletin*, Kate Foster collated and analysed the census records of all households initially contacted for the 1991 FES (Foster, 1996). The characteristics of those who ultimately completed the survey and those who did not respond were then compared. This study provides the initial input for our discussion of which demographic groups may be under-represented or over-represented within the FES. Initially, Foster provides a series of univariate tabulations illustrating how response rates differ for particular characteristics. These show that those households significantly under-represented are: households with three or more adults, households in London, households with three or more cars, households where the head is aged 65 to 74, households without post-school qualifications, households with the head born outside the UK, non-white households and the self-employed. However, it is clear that many of these factors may be correlated and Foster also presents a multivariate analysis, tabulating the odds ratios from a logistic regression for a reduced set of the variables. The key results are reported in Table 1.1 below.

The odds ratio present the probability of non-responses for the group, in comparison to the reference group which is normalised to unity. Hence the value 1.67 for households with three or more adults implies that these households were 67 per cent more likely not to respond to the FES than households with less than three adults.

Table 1.1: Odds of non-response for different household types

Characteristic	Odds	
Number of adults in household		
1 or 2	1.00	
3 or more	1.67	*
Qualification level of head of household		
Degree or equivalent	1.00	
Other higher qualification	0.63	*
No post-school qualification	1.44	*
Number of children in household		
1 or more	1.00	
none	1.36	*
Area type		
Non-metropolitan	1.00	
Metropolitan	1.09	*
London	1.44	*
Economic status of head of household		
Employed	1.00	
Self-employed	1.31	*
Unemployed	1.11	
Economically inactive	0.85	
Age of head of household		
16-34	1.00	
35-54	1.24	*
55-64	1.42	*
65-74	1.46	*
75+	1.61	*

* Coefficient significantly different from reference category at the 5% significance level. *Source: Foster (1996)*

Without access to the matched census records themselves we cannot add additional variables to this model (although later we do add further sub-categories to the number of adults and the number of children) and are hence required to take this specification as a baseline for our analysis of spending patterns. Therefore for the rest of this report we consider the following demographic variables as the dimensions in which the FES respondents are not representative of the FES sample frame:

- Number of adults
- Education of head of household
- Number of children
- Metropolitan/non-metropolitan areas, more particularly London
- Head's employment status
- Head's age

In the analysis presented in the next section we document spending patterns for broad groups of commodities by each of these variables. This analysis is analogous to the univariate tabulations presented in Foster (1996) and serves as useful background information on how spending patterns on vary across different types of household. With this in mind, we develop the analysis to consider a multivariate model for different groupings of commodities.

Non-coverage

The FES is a survey of households only and excluded from the sampling frame are residents of institutions such as prisons, hostels, educational establishments and army residences. In order to obtain an estimate of total spending by the entire population for use in the National Accounts, therefore, it would be necessary to correct the grossed-up FES figures to take account of the spending of the non-household population. One very simple method, analogous to uniform grossing, would be simply to multiply the estimates of spending

aggregates from the FES by the appropriate factor to take account of the size of the non-household population. Using information from the 1991 Census and other detailed sources on excluded populations, such as DSS and NHS surveys, Evans (1995) suggests that individuals in the non-household sector comprise between 1.7-2.1 per cent of the UK population.

However, the composition of individuals in the non-household population and also their spending patterns are likely to differ from those of individuals resident in households. Evans (1995) also provides estimates of the numbers in different sectors of the non-household population and a methodology for imputing an income level to members of each sector. With this information and additional assumptions about the average demographic profile of these households it would be possible to impute spending levels to members of certain components of the non-household population from similar household groups in the survey. We do not address this approach in this paper and simply look at correcting aggregates for non-response as opposed to non-coverage.

II Spending patterns in FES data

As background information to illustrate the degree to which spending patterns vary by the characteristics in which the FES under or over-represents the household population we present some simple tabulations of expenditure by household type, broken down into thirteen broad categories of (non-housing) spending, and also for total spending in Tables 2.1a and 2.1b. These categories are based on the grouping of goods and services in the Retail Price Index - details of the component categories of each group are given in Appendix A.

Table 2.1a: Average household spending: £ per week, 1991 FES
by age and household composition

	Age of head of household					Number of adults			Number of children		
	16-29	30-44	45-64	65-74	75+	1	2	3+	0	1	2+
Totexp	183.4	243.5	245.4	128.2	92.52	97.18	223.1	332.0	173.1	248.4	253.8
Food In	26.41	41.78	42.26	27.44	22.23	17.67	39.77	55.97	29.35	42.63	55.97
Food Out	13.64	14.87	13.85	4.69	3.17	5.17	12.42	21.04	9.74	14.74	14.54
Alcohol	12.55	12.92	14.26	5.42	3.49	4.70	11.46	22.95	10.64	12.59	10.33
Tobacco	5.27	6.32	6.81	3.04	1.34	2.65	5.20	10.93	4.52	7.29	6.00
Fuel	10.08	13.46	13.65	10.99	10.58	9.40	13.12	15.54	11.20	13.95	15.05
HH Gds	18.92	24.96	25.01	13.44	8.34	9.12	24.28	29.42	17.84	26.18	24.59
HH Serv	10.21	14.96	13.75	8.47	8.56	7.85	13.98	14.08	10.55	14.92	15.69
Clothing	15.56	21.37	19.24	8.94	4.81	6.80	17.83	29.01	12.70	22.47	22.86
Pers Gds	9.61	14.30	13.90	7.80	7.99	6.60	13.57	18.06	9.74	16.09	15.10
Motoring	34.98	41.17	46.08	19.11	9.74	12.77	38.69	66.53	31.32	42.34	39.00
Fares	7.14	6.61	7.03	2.55	2.15	3.18	5.66	10.99	5.10	7.20	6.26
Leis Gds	11.56	16.00	14.47	7.48	4.31	6.25	13.51	20.00	10.82	13.74	15.55
Leis Svs	7.43	14.75	15.07	8.78	5.81	6.03	13.57	17.46	9.54	13.43	18.52

Striking patterns emerge across household types, both in terms of the level of spending and the composition of spending. In particular, spending varies considerably according to the age of the household head, with expenditure on most goods and services exhibiting a humped-shape pattern across age-groups. There are also big differences in spending according to the number of adults in the household. For some goods and services, such as food out, alcohol, clothing and motoring, total spending increases more than proportionately with each extra adult. The effect of higher qualifications is to increase the level of spending on almost all items, tobacco being the only exception. The biggest variations in spending by area are for fares and food consumed outside the home.

Table 2.1b: Average household spending: £ per week, 1991 FES
by area, education and employment of head

	Area Type			Educ of head			Employment status of head				
	Lon	Met	Non-met	CSL	Alev	Coll	Emp	Self	Un	Ret	Unoc
Totexp	218.4	179.2	200.3	168.2	222.0	284.8	251.2	255.2	147.4	121.1	177.1
Food In	36.06	33.21	35.26	33.22	36.70	38.88	39.81	44.47	31.88	26.59	24.79
Food Out	15.11	9.88	11.10	9.39	12.69	17.12	15.91	15.63	6.89	4.40	5.81
Alcohol	12.79	11.39	10.32	10.01	11.31	13.77	14.31	15.34	9.24	5.32	4.78
Tobacco	4.46	6.16	4.91	6.06	4.36	2.44	5.97	6.28	8.17	2.60	3.73
Fuel	11.74	12.13	12.38	11.64	13.07	13.39	12.67	14.51	12.06	10.90	11.63
HH Gds	21.58	17.46	20.81	17.09	23.44	27.46	24.77	29.93	14.98	12.49	11.95
HH Servs	16.74	9.86	12.03	9.32	13.09	23.07	15.29	14.28	6.90	8.62	7.40
Clothing	16.61	15.56	15.75	13.56	17.99	21.80	21.45	20.15	10.16	7.78	9.70
Pers Gds	13.73	10.53	11.67	9.01	14.09	18.88	14.50	15.22	6.67	8.07	7.76
Motoring	31.52	28.64	36.43	27.28	41.13	51.39	47.84	40.56	20.61	18.84	11.49
Fares	11.22	5.12	4.82	4.23	5.57	12.23	7.62	6.63	4.59	2.38	3.75
Leis Gds	11.11	10.41	12.78	10.08	13.39	18.72	15.78	16.07	8.65	6.56	7.16
Leis Svs	15.73	8.83	12.00	7.29	15.15	25.36	15.26	16.08	6.58	6.57	7.80

These tables provide some guide as to how demographic factors affect overall spending patterns. Differences may arise as a result of differences across groups in the proportion of non-zero expenditures, or as a result of systematic differences in the level of spending for spenders. Unlike in a structural model of expenditure behaviour, however, in the analysis that follows there is no need to distinguish between these two explanations since the grossing up exercise needs to control for both components of the observed differences across groups.

There are some goods, such as fuel, where households' demographic composition appears to have a smaller effect on average spending across groups.[1] We need to establish whether there is variation in expenditures for which the FES is used in constructing National Account aggregates and hence we carry out a similar analysis for the thirty goods and services listed in Table 2.2. As the commodity classification gets finer, however, there are greater problems in identifying genuine variation in spending patterns among different types of households as the incidence of zero observations increases. This is shown in Table 2.2 which

[1] This may be an artefact of aggregating individiaul commodity spending. It is likely, for example that both gas and electricity spending show strong patterns across groups but that these average out in total.

summarises information on spending on 28 of the individual goods and services where FES data is used in calculating total expenditure.[2]

Table 2.2: Proportion of non-zero expenditures and average weekly expenditures in the FES

	Proportion of households with spending > 0	Average weekly expenditure (£) (non-zeros only)
Accommodation (self-catering, hotels etc.)	0.26	28.70
Take away food	0.68	5.31
Meals out	0.67	8.96
Books	0.25	4.50
Newspapers, magazines	0.88	2.92
Seeds, plants and flowers	0.29	3.95
Dry cleaning	0.05	3.53
Entertainment - miscellaneous	0.21	3.81
Hairdressing, beauty treatment	0.37	4.75
Laundry and launderette charges	0.04	2.40
Medical treatment	0.04	21.96
Spectacles	0.51	2.65
Postage	0.46	1.16
Telephone charges	0.87	5.49
Repairs to footwear	0.04	2.11
Repairs to clothing	0.03	11.38
Repairs to TV audio and video goods	0.01	12.69
Repairs to gas/ central heating	0.03	11.52
Participant sports	0.30	3.53
Spectator sports	0.03	5.40
Theatres, concerts, circuses	0.05	9.40
Structural insurance	0.62	2.76
Contents insurance	0.76	1.64
Cleaning materials	0.79	2.12
Motor vehicle costs (repairs,services,accessories etc)	0.68	1.42
Taxis	0.19	4.25
Social subscription	0.13	2.55
Pet care	0.41	4.80

For several of the goods and services, such as newspapers and magazines, telephone charges and cleaning materials, the proportion of non-zero observations remains fairly high. However, for other items such as laundry and launderette charges, repairs to footwear and spectator sports, the proportion falls below five per cent - and is even less than 1 per cent in the case of repairs to TV, audio and video goods. With so few positive observations it is

[2] There are two items which we cannot identify from the available FES data. The first is repairs to bicycles which are not identified separately in the FES derived data and the second is financial services which are not specified in sufficient detail.

almost impossible to identify (in an econometric sense) systematic variation in spending patterns between different household types. In order to reduce the incidence of zeros, therefore, in the econometric analysis that follows it is necessary to group goods together to form expenditure bundles. Ideally the grouping should be such that preferences and needs can be assumed to vary commonly for all goods within a group: we carry out multivariate analysis of spending patterns for the broad thirteen groups, the individual goods and services for which the FES is used to estimate National Accounts spending totals and also a grouping of 70 goods and services used in the Retail Price Index. Details of this are given in Appendix A. With this in mind, we carry out univariate analysis of spending on the 28 items as before. The results are given in Tables 2.3a and 2.3b.

Table 2.3a: Average household spending: £ per week, 1991 FES
by age and household composition

	Age of head of household					Number of adults			Number of children		
	16-29	30-44	45-64	65-74	75+	1	2	3+	0	1	2+
Accom	4.07	9.13	10.60	6.00	2.96	3.00	9.14	11.84	7.42	6.56	8.65
Takea	5.25	5.22	3.91	1.01	0.87	1.69	3.79	7.45	2.90	5.35	5.06
Meals	6.24	7.00	8.06	3.48	2.19	2.81	9.81	10.43	5.72	7.13	6.34
Books	0.99	1.38	1.42	0.77	0.35	0.56	1.23	1.90	0.96	1.31	1.53
News	1.62	2.46	3.26	2.57	2.23	1.63	2.75	4.01	2.59	2.61	2.41
Seeds	0.79	1.20	1.62	1.00	0.53	0.47	1.42	1.65	1.13	1.26	1.11
Drycln	0.18	0.18	0.19	0.12	0.09	0.11	0.18	0.20	0.11	0.14	0.18
Enter	0.97	1.09	1.02	0.32	0.20	0.25	0.91	1.77	0.64	1.14	1.25
Hairdr	1.28	1.70	2.18	1.82	1.38	0.97	2.03	2.53	1.74	1.96	1.69
Laundr	0.17	0.07	0.11	0.06	0.09	0.10	0.09	0.10	0.10	0.09	0.08
Medic	0.12	1.15	0.86	0.66	1.11	0.53	0.98	0.89	0.76	0.37	1.42
Specs	1.88	1.84	1.24	0.74	0.72	0.56	1.77	1.55	0.84	2.62	2.40
Post	0.32	0.46	0.66	0.63	0.55	0.41	0.58	0.68	0.54	0.57	0.50
Phone	4.16	5.75	5.38	3.88	3.16	3.49	5.19	6.22	4.37	5.22	6.04
Shoerep	0.06	0.08	0.12	0.09	0.09	0.04	0.12	0.10	0.10	0.07	0.08
Clotrep	0.15	0.34	0.35	0.13	0.40	0.19	0.29	0.50	0.28	0.16	0.41
TVrep	0.13	0.12	0.15	0.20	0.09	0.13	0.14	0.16	0.15	0.09	0.14
Gasrep	0.12	0.27	0.37	0.45	0.38	0.18	0.34	0.58	0.32	0.42	0.25
Particsp	0.96	0.62	0.31	0.47	0.17	0.33	1.28	1.95	0.91	1.39	1.41
Specsp	0.16	0.38	0.16	0.03	0.01	0.07	0.21	0.32	0.13	0.35	0.25
Theatre	0.34	0.56	0.84	0.32	0.14	0.21	0.58	0.94	0.54	0.58	0.37
Str_ins	1.18	2.14	2.07	1.38	1.04	0.98	2.04	2.15	1.56	1.83	2.21
Con_ins	1.03	1.45	1.47	1.06	0.76	0.77	1.47	1.47	1.16	1.37	1.47
Clnmat	1.38	2.13	2.00	1.22	0.88	0.86	1.92	2.63	1.31	2.22	2.68
Car	0.85	1.20	1.28	0.58	0.31	0.38	1.12	1.66	0.87	1.14	1.18
Taxis	1.05	0.88	1.02	0.46	0.35	0.59	0.67	1.91	0.80	1.12	0.65
Soc subs	0.07	0.44	0.43	0.37	0.18	0.22	0.36	0.55	0.31	0.29	0.50
Pet care	1.62	2.57	2.53	1.18	0.67	0.94	2.29	3.02	1.85	2.25	3.02

Similar variations emerge in the patterns of spending on the 28 goods and services by household type as we saw for the thirteen broad categories in Tables 2.2a and 2.2b. As before, the pattern of expenditure by age is broadly hump-shaped. Spending increases with the number of adults in the household and for some items, accommodation, take-away food, meals out and car costs, for example, the increase is more than proportional. Higher levels of education tend to be associated with higher levels of spending.

Table 2.3b: Average household spending: £ per week, 1991 FES
by area, education and employment of head

	Area Type			Educ of head			Employment status of head				
	Lon	Met	Non-met	CSL	Alev	Coll	Emp	Self	Un	Ret	Unoc
Accom	7.82	7.42	7.54	5.50	9.23	13.73	10.11	9.45	3.31	5.44	1.97
Takea	4.51	3.64	3.45	3.40	3.67	4.50	5.04	5.78	2.65	1.03	2.03
Meals	8.60	4.64	6.06	4.54	7.31	10.31	8.13	8.33	3.32	3.20	3,06
Books	1.51	0.87	1.12	0.72	1.23	2.70	1.45	1.61	0.72	0.57	0.66
News	2.59	2.38	2.86	2.41	2.75	2.86	2.77	2,68	2.11	2.51	1.89
Seeds	1.02	0.93	1.24	0.89	1.46	1.69	1.39	1.67	0.54	0.93	0.48
Drycln	0.31	0.13	0.15	0.12	0.19	0.33	0.21	0.13	0.12	0.11	0.12
Enter	0.80	0.73	0.85	0.68	0.97	1.10	1.16	1.07	0.42	0.33	0.45
Hairdr	1.95	1.67	1.76	1.49	2.08	2.36	2.00	2.12	0.88	0.66	1.23
Laundry	0.21	0.08	0.08	0.08	0.09	0.21	0.11	0.08	0.05	0.08	0.15
Medic	1.29	0.30	0.94	0.42	1.39	1.57	0.82	0.94	0.26	0.82	1.39
Specs	1.49	1.19	1.39	1.19	1.47	1.86	1.71	1.62	1.20	0.74	1.05
Post	0.63	0.41	0.56	0.40	0.63	0.99	0.54	0.62	0.40	0.60	0.38
Phone	5.90	4.21	4.80	3.99	5.47	7.05	5.74	4.82	3.72	3.72	3.81
Shoerep	0.13	0.07	0.10	0.09	0.09	0.12	0.10	0.07	0.05	0.11	0.07
Clothrep	0.32	0.28	0.28	0.19	0.31	0.69	0.38	0.33	0.05	0.25	0.10
TVrep	0.10	0.21	0.12	0.17	0.08	0.11	0.13	0.08	0.17	0.08	0.11
Gasrep	0.25	0.32	0.33	0.26	0.38	0.50	0.33	0.34	0.14	0.46	0.04
Particsp	1.05	0.96	1.10	0.78	1.44	1.61	1.60	1.39	0.63	0.39	0.21
Specsp	0.13	0.26	0.16	0.17	0.19	0.20	0.29	0.26	0.08	0.03	0.04
Theatre	1.04	0.34	0.49	0.26	0.60	1.57	0.75	0.71	0.11	0.29	0.10
Str_ins	1.86	1.44	1.79	1.29	2.20	2.72	2.09	2.44	0.94	1.33	0.82
Cont_ins	1.70	1.16	1.20	0.97	1.50	2.02	1.47	1.82	0.76	0.98	0.70
Cleanmat	1.77	1.54	1.71	1.64	1.73	1.71	2.01	2.21	1.47	1.09	1.25
Car costs	0.83	0.79	1.04	0.81	1.12	1.31	1.23	1.61	0.65	0.54	0.34
Taxis	1.35	0.90	0.69	0.81	0.72	1.05	1.06	0.87	0.68	0.38	0.82
Soc subs	0.63	0.26	0.32	0.21	0.40	0.87	0.45	0.44	0.14	0.24	0.12
Pet care	1.24	1.42	2.25	1.81	2.13	2.29	2.33	3.82	1.37	0.99	1.31

Tables 2.3a and 2.3b show that similar patterns on spending emerge for the much finer classification of goods and services as for the broad commodity groups. This analysis suggests that even if there are not enough non-zero observations to identify a model for some of the finer classifications, grossing factors chosen according to estimation from broader groups will still pick up appropriate differences in spending.

Multivariate analysis of spending patterns

The simple univariate analyses of the previous section revealed important variations in spending patterns by household type across several dimensions - age, number of adults, number of children, area type, education and employment status. However, it is possible that some of the household characteristics that we looked at may be correlated. For example, a high proportion of households with one adult are likely to be retired and over 75. We therefore carry out a multivariate analysis of spending patterns to determine which characteristics have a significant effect on expenditure, conditional on all other factors. When we come to computing the grossing factors, there is a trade off between increasing the number of dimensions that the grossing system controls for and the grossing factors' numerical empirical properties. Hence we will want to keep the grossing system as parsimonious as possible and control only for those dimensions of the population that have an independent significant effect on expenditure.

Models of spending estimated from UK micro-data have tended to be of the Almost Ideal (see Deaton and Muellbauer, 1980) or Quadratic Almost Ideal form (see Banks, Blundell and Lewbel, 1997) in which the share, w, of total expenditure, X, allocated to each commodity (indexed by $i = 1,..,N$) has the following form:

$$(1)\quad w = \alpha' z + \sum_{i=1}^{N} \gamma_i \ln p_i + \beta \ln\left(\frac{X}{P}\right) + \lambda(p) \ln\left(\frac{X}{P}\right)^2$$

where P is an appropriate price deflator. In the Almost Ideal model $\lambda(p) = 0$. These models of spending patterns have been shown to match observed household demand patterns in estimation from the Family Expenditure Survey from 1974 onwards. Hence they might be expected to be a good point of departure from which to observe demand variation across the FES population. However there are two reasons why we do not want to use this model in estimating differences in spending patterns. First, with only one year of data and with the FES being a random sample within each quarter of the year differences in prices should not drive differences in spending, and hence we can ignore the price terms in (1). Second, and more importantly, whilst the model in (1) may be an accurate representation of spending, in the grossing up exercise itself a control total for total expenditure does not exist. Hence establishing differences in spending patterns *conditional* on total spending risks missing out important effects. For example, if education affects total spending but not the composition of spending then education variables would not appear significant in the estimation of the share equation (1). But that is not to say that education does not affect the level of spending on any particular good and hence differences across households which one would want to account for when grossing (using non-expenditure control totals) will be ignored.

We therefore estimate the following multivariate demand models for the level of household spending on different goods and services,

$$(2)\quad x_i^h = \alpha_i + \beta_i' z^h + u_i^h$$

where x_i^h is the level of spending[3] on good i by household h and z^h is a vector of household characteristics encompassing the main dimensions of the population identified by

[3] In what follows we assume that any measurement error in x is uncorrelated with the demographic variables we include in the model. This is no more severe than what would have been the case if we had known the true model without having to estimate parameters —in all exercises that involve grossing up sample data to population aggregates simple algebra

Foster (1996) - age of the household head, number of adults in the household, number of children in the household, education of the head, employment status of the head of the household and area of residence. As we are estimating the demand model on the level of spending, we cannot assume that the errors are homoscedastic, since the size of random variation is likely to be correlated with the overall level of expenditure. Hence we compute White standard errors for use in evaluating the statistical significance of observed demand differences (see Greene, 1994, for example, p. 391).

We estimate models of spending separately for all goods and services grouped into thirteen and then seventy different categories. We also estimate a demand model separately for the 28 individual goods and services where the FES is used to estimate National Accounts spending totals. However, as has already been discussed before, as the incidence of zero expenditures increases, it becomes difficult to identify significant variation in spending across different types of households. We report the results for the thirteen and 28 good model below. The results of the 70 good model are reported in Appendix B. For each good we report the coefficients on each of the demographic variables (but not the constant). An asterisk denotes that the coefficient is significant at the 5 per cent significance level relative to the base household which is defined as having a 16-29 year-old head, one adult, no children, a college-educated unemployed head living in a non-metropolitan area.

The results of the multivariate analysis confirm many of the findings of the univariate analyses of the previous section. Looking first at the estimation results from the thirteen good model in Table 2.4 and considering in turn each of the six different dimensions we have highlighted in which the FES is unrepresentative of the UK population: age, number of adults and children, employment and education of the head and area of residence, spending levels

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shows that any measurement error in the variable of interest that is correlated with the weights being used to gross-up will lead to biased estimates of population totals.

vary significantly across each dimension. The number of adults affect spending significantly - and positively - for all thirteen goods, as we might expect, the education variables only fail to affect level of alcohol spending, while the employment variables fail to enter significantly only in the tobacco equation. In only three of the equations - household goods, clothing and leisure goods - do we find that none of the age variables enter significantly, while the number of children and the area dummies both enter significantly in eight of the equations.

If we look at the results of the 28 good model in Table 2.5 we find fewer significant coefficients as we might expect from the increased number of zero observations. In the case of TV and video repairs, for example, where less than one per cent of households in the FES sample recorded positive expenditures, none of the variables enter significantly. It is impossible to identify whether this is because of the lack of non-zero observations or whether there is genuinely no variation by household type. The results from estimating the 70 good model, however, do show that spending on a broader group of 'audio-visual goods' (which includes repairs to TV and video) does vary significantly by household type. Assuming that preferences vary commonly across all goods within this group, we can infer that the same is true of repairs to TV and video.

Even at the highly disaggregated 28 good level, however, there are many cases of significant spending variation across the key six dimensions. In the case of spending on theatres, concerts and circuses, for example, where we observe only five per cent of the FES sample with positive expenditures, there is nevertheless significant variation by age, number of adults, education and employment status of the head of household and area of residence.

Key

a2	age of head 30-44	2+kid	two or more children
a3	age of head 45-64	ed1	compulsory education only
a4	age of head 65-74	ed2	A levels
a5	age of head 75+	emp	head employed
2ad	two adults in household	self	head self-employed
3+ad	three or more adults	lond	London
1kid	one child in household	met	Metropolitan area

Table 2.4: Multivariate demand model: 13 good model

	a2	a3	a4	a5	2ad	3+ad	1kid	2+kid	ed1	ed2	emp	self	lond	met
Foodin	5.82*	11.7*	11.4*	9.42*	16.4*	32.7*	-18.3*	-8.45*	-4.21*	-1.77*	4.63*	7.03*	3.03*	-0.72
Foodout	-1.21*	-2.41*	-4.09*	-4.26*	4.50*	13.5*	-0.25	-0.22	-4.66*	-2.21*	6.35*	5.96*	3.88*	-0.41
Alco	-0.50	-2.83*	-5.81*	-6.33*	5.62*	16.7*	5.55*	1.73*	-1.47	-0.54	4.13*	5.07*	2.62*	1.63*
Tobac	0.91*	-0.19	-2.82*	-4.17*	1.75*	7.04*	0.38	0.90*	4.22*	2.44*	-0.46	-0.35	0.19	1.01*
Fuel	1.50*	2.96*	2.45*	2.55*	2.75*	5.11*	-3.74*	-1.18*	-1.92*	-0.56	-0.20	1.28*	-0.35	0.03
HHGd	2.20	3.11	0.42	-2.40	11.7*	16.1*	-0.33	2.36	-7.56*	-2.42	4.98*	9.60*	1.19	-1.92
HHSv	2.14	4.44*	5.00*	5.95*	3.96*	4.10*	-3.69*	-0.09	-12.1*	-9.27*	5.32*	4.01*	4.14*	-1.16
Cloth	1.17	0.90	0.78	-1.43	6.80*	18.6*	-5.72*	-0.91	-5.57*	-2.11	7.15*	5.35*	1.22	0.78
PersGd	1.23*	3.35*	4.30*	5.86*	6.00*	10.6*	-3.98*	1.82	-8.95*	-4.39*	4.21*	4.52*	2.03	-0.10
Motor	-1.54	0.50	-4.08	-8.66*	19.5*	46.8*	4.21	1.59	-18.9*	-7.09	17.3*	9.24*	-4.98	-4.88*
Fares	-1.42*	-1.11	-2.52*	-2.23*	1.70*	7.19*	0.24	0.46	-6.67*	-5.57*	2.11*	1.18	5.81*	0.66
LGds	2.02	0.37	-0.72	-2.74	4.74*	11.6*	-0.27	-1.54	-6.69*	-4.16	4.25*	4.34*	-1.92	-1.61*
LServ	1.95*	7.78*	9.79*	8.01*	4.20*	8.43*	-9.29*	-5.28*	-17.1*	-10.1*	5.94*	6.22*	2.92	-1.64

Table 2.5: Multivariate demand model: 28 good model

	a2	a3	a4	a5	2ad	3+ad	1kid	2+kid	ed1	ed2	emp	self	lond	met
Accom	3.26*	5.09*	5.01*	3.05*	5.03*	7.01*	1.00	-1.64	-7.36*	-4.22*	4.26*	3.24*	0.19	0.82
Take	-0.79*	-2.42*	-2.89*	-2.62*	1,07*	5.16*	-0.29	0.08	0.04	0.11	1.81*	2.58*	1.09*	0.32*
Rest	-0.32	0.46	-0.49	-1.05	3.06*	6.42*	1.31*	0.67	-4.52*	-2.19*	2.99*	3.10*	2.34*	-0.82*
Book	0.00	0.33	0.41	0.09	0.40*	1.11*	-0.43	-0.25	-1.86*	-1.40*	0.43*	0.58	0.25	-0.14
News	0.56*	1.17*	1.30*	1.17*	1.14*	2.18*	0.20*	0.14	-0.53*	-0.22	0.40*	0.16	0.10	-0.12
Seeds	0.20	0.62*	0.55*	0.25	0.83*	0.91*	0.28*	0.20	-0.74*	-0.23	0.41*	0.63*	-0.19	-0.18
Drycln	-0.02	-0.00	-0.01	-0.03	0.07*	0.09	0.02	-0.03	-0.18*	-0.11	0.06	-0.02	0.15*	-0.01
Ent	-0.19	-0.21	-0.27*	-0.27*	0.41*	1.36*	-0.36*	-0.21	-0.27*	-0.01	0.41*	0.30*	-0.04	-0.06
Hairdr	0.10	0.66*	1.14*	0.91*	1.04*	1.43*	0.08	0.25	-0.88*	-0.32	0.61*	0.64*	0.24	0.07
Laundr	-0.10*	-0.06	-0.09*	-0.07	-0.01	0.01	0.01	-0.00	-0.10*	-0.08*	0.01	-0.01	0.11*	-0.00
Primed	0.66*	0.63	0.56	1.06	0.43	0.48	-0.61	-0.91	-1.16	-0.23	-0.25	-0.19	0.29	-0.54*
Specs	-0.57*	-0.46*	-0.22	-0.10	0.82*	0.82*	-1.39*	-0.21	-0.51*	-0.27	0.26*	0.15	0.14	-0.13
Post	0.02	0.32*	0.48*	0.44*	0.18*	0.26*	-0.10*	0.05	-0.66*	-0.43*	0.05	0.10	0.03	-0.11*
Phone	0.80*	1.03*	0.95*	0.47*	1.07*	2.20*	-1.08*	-0.74*	-2.59*	-1.36*	1.03*	0.02	1.00*	-0.36*
Shoerep	0.01	0.05*	0.04	0.04	0.09*	0.06*	0.03	-0.00	-0.04	-0.04	0.01	-0.04	0.04	-0.02
TVrep	-0.03	0.01	0.11	0.01	0.02	0.03	-0.00	-0.06	-0.01	-0.05	0.11	0.01	-0.02	0.09
Gasrep	0.06	0.17*	0.47*	0.45	0.19*	0.43*	-0.02	0.16	-0.32*	-0.18	0.11	0.10	-0.08	0.02
Clotrep	0.08	0.17	0.18	0.48*	0.06	0.29	-0.15	-0.26	-0.48	-0.38	0.23	0.17	0.01	0.04
Partip	0.37*	0.03	-0.01	-0.13	0.65*	1.36*	0.13	0.05	-0.53*	0.01	0.73*	0.51*	-0.04	-0.03
Specsp	0.21*	-0.03	-0.03	-0.02	0.07	0.18*	0.09	0.15	-0.06	0.05	0.16*	0.14	-0.02	0.10
Theat	0.15	0.42*	0.31*	0.19	0.31*	0.56*	0.30*	0.23	-1.20*	-0.91*	0.35*	0.30	0.47*	-007
Str_ins	0.52*	0.77*	0.88*	0.73*	0.75*	0.85*	-0.33*	-0.26*	-1.26*	-0.47*	0.65*	0.94*	0.05	-0.17*
Con_ins	0.18*	0.41*	0.52*	0.33*	0.55*	0.51*	-0.10	-0.03	-0.91*	-0.46*	0.42*	0.74*	0.48*	0.08
Clnmat	0.23*	0.52*	0.54*	0.34*	0.64*	1.37*	-1.22*	-0.51*	-0.10	0.09	0.43*	0.51*	0.20*	-0.11*
Cars	0.13*	0.19*	0.05	-0.09*	0.53*	1.02*	0.04	-0.02	-0.35*	-0.11*	0.40*	0.74*	-0.17*	-0.17*
Taxis	-0.15	-0.31*	-0.46*	-0.52*	0.02	1.23*	0.35*	0.34*	-0.07	-0.18	0.31*	0.13	0.65*	0.20*
Socsub	0.22*	0.37*	0.61	0.44*	0.06	0.26	-0.23*	-0.20*	-0.63*	-0.47	0.29	0.25	0.27	-0.01
Petcare	0.76*	0.38	-0.21	-0.51	0.94*	1.50*	0.70*	0.28	-0.15	0.01	0.49*	1.91*	-0.95*	-0.70*

In conclusion, the results of the multivariate analysis confirm the results from simple cross-tabulations: spending patterns vary considerably for household type, including spending on the goods and services for which FES data is used to construct National Accounts spending totals. This necessitates the use of differential grossing factors if we are not to over- or under-record total UK spending and in the next section we will discuss in detail the construction of weighted grossing factors.

III Computation of Grossing Factors

The process of 'grossing-up' survey data to population aggregates requires computing a set of weights, referred to as grossing factors, by which each household's information can be multiplied such that a total corresponding to the aggregate population can be reached. This section describes the process of computing these weights from the distribution of characteristics reported in the census and the demographic information in the Family Expenditure Survey.[4]

The most straightforward means of constructing aggregate totals is by using uniform grossing factors computed simply by assigning each household in the survey an equal weight, $\overline{g}$, given by the ratio of the number of household in the population to the number of households in the survey, $\overline{g} = N/n$. As an example, the 1991 Census indicates that there are 22,427,691 households in Great Britain so each of the (7,056) households in the 1991 FES sample has to be assigned a weight of 3178.5 in computing population totals.

The fact, however, that certain sub-groups of the population are under- or over-represented in the survey means that the uniform grossing-up weights will not be the optimal choice of survey weight. Furthermore, the fact that expenditure patterns have been shown to vary systematically across these different household types, the sample composition should be

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[4] What follows is well known. For a more detailed discussion see Atkinson, Gomulka and Stern (1983) or Sautory (1992).

taken into account at the grossing-up stage. For example, in computing Households Below Average Income statistics or benefit recipient numbers from FES data, the DSS allow grossing-factors to differ by age, sex, marital status and benefit unit size when weighting the data to produce aggregate totals (see DSS, 1994). Uniform grossing assumes that differences in household spending are not attributable to anything in particular about the household itself. But if household types have different tastes and, more importantly, different needs the compositional effects on spending patterns will be such that aggregate totals may be mismeasured. The more systematic the non-response across household types, the more important it is to gross-up expenditure totals non-uniformly.[5]

The most simple non-uniform grossing weights can be computed when households are assumed to differ in one dimension only, say, for example, by marital status. If the FES undersamples married couples then the use of uniform grossing factors would lead to an aggregate total corresponding to a population that was disproportionately made up of single households. This could be rectified by allowing grossing factors to differ by marital status — if the fraction of census households that are married is φ_m and the fraction of the FES sample observed to be married is $\tilde{\varphi}_m$ then the correct grossing factor for a married household should clearly be $g^m = \frac{N\varphi_m}{n\tilde{\varphi}_m} = \frac{\bar{g}\varphi_m}{\tilde{\varphi}_m}$. Similarly for a single household, $g^s = \frac{N(1-\varphi_m)}{n(1-\tilde{\varphi}_m)} = \frac{\bar{g}(1-\varphi_m)}{(1-\tilde{\varphi}_m)}$.

Typically, however, it will be necessary to allow households to differ in more than one dimension in computing grossing factors. In this case the problem is more difficult since the true joint distribution of the characteristics of interest in the population as a whole is not known without access to the complete census dataset.[6] More usually, only the marginal

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[5] However, if all household types had similar spending patterns then the problem would be small, despite the differential non-response, when computing National Accounts expenditures. It is the conjunction of systematic difference in needs or tastes across households and an over- or under-representation of some of these households that generates the need for differential grossing-up factors specifically for household expenditures.

[6] If the exact number of households in each cell of the demographic breakdown was known then the same technique as in the one-variable case could be applied — each households grossing factor would just be equal to the ratio of the number of households actually in their cell in the census to the number of households observed to be in their cell in the sample population.

distributions of individual characteristics within the census data are available, and this is indeed the case in the UK. Since the conditions that a vector of grossing factors must meet are that a) the weighted number of households in each dimension must sum to the total number of households and b) each household should have a grossing factor of at least one, there will be a number of sets of grossing factors that could be chosen. More precisely, for each demographic characteristic (defined as a dummy variable taking the value zero or one), z_k, to which there is a corresponding population total N_k, it must be the case that

$$\sum_{h=1}^{N} z_k^h g^h = N_k \qquad \text{for all k = 1,... K.} \tag{3}$$

Since this is a system of K linear equations and there are N households (where N is much greater than K) there will be more than one set of weights g^h that satisfy (3). It remains to choose the set of grossing factors that satisfy this condition whilst deviating least from some arbitrarily defined starting values which, in this project, we take to be the uniform grossing weights, $\overline{g}$. This means that we choose the solution in which the distribution of grossing factors is the most clustered which ensures individuals households expenditure will not have extreme weight in the grossed-up total. The minimisation problem can be written as

$$\min L = \sum_{h=1}^{N} \overline{g}\, D\left(\frac{g^h}{\overline{g}}\right) - \lambda\left(\sum_{h=1}^{N} z_k^h g^h - N_k\right) \tag{4}$$

where D(·) is the function specifying the 'distance' between computed weights and starting weights and λ is the (Kx1) vector of Lagrange multipliers. The choice of distance function can be specified to ensure that all grossing weights remain positive and fall within a prescribed range. The grossing factors we provide in this paper are computed using the logit method of Sautory (1992a) which takes D(·) to be

$$D(v) = \left((v-g_l)\log\frac{v-g_l}{1-g_l} + (g_u - v)\log\frac{g_u - v}{g_u - 1}\right)\frac{(1-g_l)(g_u-1)}{g_u - g_l} \quad \text{if } g_l < v < g_u,$$

$D(v) = \infty$ otherwise

such that the inverse function of the derivatives of D takes the logistic form.

One example of the above technique is the set of differential grossing factors constructed by the DSS for use in calculating their Households Below Average Income (HBAI) statistics. These correct for known differential rates of response to the FES in three dimensions - age, sex, marital status and benefit unit size (for further discussion see DSS, 1994) and are summarised in Table 3.1. Since the numbers are frequency weights a high grossing factor implies that the relevant group is underrepresented. These HBAI differential grossing weights have also been used in longer time-series studies of income and expenditure distribution using FES data (see Goodman and Webb, 1995a and 1995b, for example) and have also been used to compare year-on-year growth rates of differentially grossed-up FES expenditure totals with corresponding measures from the National Accounts (Tanner, 1996).

Table 3.1: Differential (HBAI) grossing factors Computed from 1991 FES and Census Data

Benefit Unit Type	*Grossing Factor (frequency weight)*
Uniform grossing factor	*3,178.5*
Married Couple, No Children	3,703.9
Married Couple, 1 Child	3,081.0
Married Couple, 2 Children	2,984.3
Married Couple, 3+ Children	2,700.0
Married Couple, Age 65-74	3,334.0
Married Couple, Age 75+	3,418.0
Single Male, Age less than 29	4,387.9
Single Male, Age 30-54	3,406.7
Single Male, Age 55-64	3,195.9
Single Female, Age less than 19	3,755.3
Single Female, Age 20-39	3,494.5
Single Female, Age 40-59	3,159.4
Male Single Parent	4,716.0
Female Single Parent	3,450.6
Male Single Pensioner, 65+	2,784.8
Female Single Pensioner, 60-74	3,061.6
Female Single Pensioner, 75+	3,342.7

However, the use of HBAI grossing factors would not be ideal for grossing up FES expenditure data. The spending information in the FES is given at the household level and it is virtually impossible to attribute expenditures to individual household members or benefit units. But the HBAI grossing factors are computed from benefit unit data and while it may be possible to aggregate benefit unit grossing factors to the household level, this technique does not accommodate possible spillover effects of multiple benefit units living in the same households (such as may be important in the multiple adult case). Computation of true household grossing factors from household level control totals will relax this restriction. In addition, the HBAI grossing factors correct for survey non-response in only four dimensions - age, sex, marital status and benefit unit. We have shown that age and size are both important determinants of household spending patterns and we will want to control for the unrepresentativeness of the FES in both these dimensions. However, this list is not exhaustive either of the dimensions in which the FES under- or over-represents different household types, or of the dimensions in which spending patterns vary across household type. In the next section we present estimates of household-level grossing factors.

Grossing factors for the 1991 FES

The first step in obtaining a set of grossing factors is to compute control totals for the population as a whole for the demographic variables of interest. For the most part, this is straightforward given the tabulations presented in the census reports for Great Britain and Northern Ireland. The expenditure analysis in section III, taken together with the reporting of sample non-response rates in section II suggests that grossing factors will be required to control for age, household composition (number of adults and number of children), education, employment status and area-type. Control totals for these tables (along with FES sample frequencies) are given in Table 3.2. The populations in the census reports for Great Britain and

Northern Ireland are aggregated to yield totals for the number of households of various sizes and in which the head of household falls into various agebands[7].

A number of issues are worth raising. Firstly, for the household composition variables we choose to use a classification that is finer than that reported by Foster (1996) in the study of non-response. This corresponds to our model of spending (and other estimated models, see for example Banks and Johnson (1994)) which show differences between one and two adult households as well as differences by the number of children rather than simply the presence of children. This specification for grossing factors nests the broader classification of household size in the sense that if it was the case that these characteristics affected spending but not non-response the estimates of grossing factors would still be consistent. But, the control totals presented in Table 3.2 do suggest differences between the Census and FES in these finer categories.

Some adjustments to census totals are required in computing control totals for the employment status and education of the head of household variables. Both these demographic characteristics are referred to as 'hard to code items' and for reasons of economy are coded only for ten per cent of the sample of households and need to be aggregated to the population level. (For further details see Dale and Marsh, 1993). The Great Britain census reports give a tabulation of the proportion of heads of household falling into each employment status category for the 10% sub-sample of households. These proportions are assumed constant in application to the total population of households. However, in the case of education the breakdown of education status is given for all adults rather than of heads of households. In addition, the breakdown is analysed on the basis of qualifications obtained as opposed to the age left full-time education reported in the FES. As a consequence we reduce the education

[7] In this analysis we are forced to ignore the comparability issue relating to the differences in definition of a household between the FES and the Census. The FES sample frame picks up individuals living at the same address with common housekeeping and having meals prepared jointly with exclusive use of at least room. In contrast, the Census records a household as all individuals residing at the same address. This difference may account for some part of the differences in population proportions reported in table 3.2.

split into two groups — households with no higher qualifications (which in the FES we define as leaving full-time education at 18) and those with some higher qualifications of whatever form. We also need to adjust the all-adults distribution to approximate the distribution of higher qualifications among heads of household. In particular,

Table 3.2: Demographic composition
1991 Census and 1991 FES

	1991 Census		1991 FES	
	Number	per cent	Number	per cent
Total number of households	22,427,691	100.0%	7,056	100.0%
Number of adults in household				
1 adult	6,929,163	30.90%	2,248	31.86%
2 adults	11,645,522	51.92%	3,873	54.89%
3 or more adults	3,848,678	17.16%	935	13.25%
no adults, dependent children only	5,328	0.02%		
Number of children				
no dependent children	15,634,570	69.71%	4,871	69.03%
1 dependent child	2,830,927	12.62%	890	12.61%
2 or more dependent children	3,962,194	17.67%	1,295	18.35%
Age of household head				
16-29	3,013,977	13.44%	1,027	14.55%
30-44	6,277,749	28.00%	1,957	27.74%
45-pensionable age	6,579,085	29.34%	2,015	28.56%
pensionable age-74	3,807,968	16.99%	1,214	17.21%
75+	2,742,793	12.24%	843	11.95%
Economic activity of head				
employee	10,354,960	46.18%	3,327	47.15%
self-employed	2,171,366	9.68%	661	9.37%
on government scheme	104,016	0.46%	23	0.33%
unemployed	1,260,759	5.62%	348	4.93%
economically inactive	8,536,590	38.06%	2,697	38.22%
Education of head				
no higher qualification	19,171,618	85.48%	6,200	87.87%
higher qualification	3,256,073	14.52%	856	12.13%
Area type				
London	2,763,166	12.33%	760	10.77%
Metropolitan area	6,455,159	28.78%	1,612	22.85%
Non-metropolitan area	13,209,366	58.89%	4,684	66.38%

we need to adjust the proportion with higher qualifications to take account of the fact that a higher proportion of household heads are male and a higher proportion of men than women have some higher qualification. In practice this means calculating a weighted average of the proportion of men and women with higher qualifications where the weights are our estimated proportions of household heads who are male and female.[8]

Similarly, the Northern Ireland census totals for employment status and education are not reported at the head of household level so we are forced to make similar adjustments, by calculating weighted averages as before. In this case the task is made easier since the census reports do give the actual proportions of household heads who are male and female.

With the relevant control totals and a dataset containing the values of each demographic characteristic of each observation in the 1991 FES is possible to compute grossing factors by finding the solution to (4), having chosen a set of starting values (which we take to be the uniform grossing weights of 3178.5 for each household) and a range in which the final grossing factors must lie. For this project these grossing factors were computed using the CALMAR package — a macro designed for exactly this task that runs in SAS (for further description see Sautory (1992b). Care must be taken to ensure that the final values lie sufficiently within the range of lower and upper bounds such that the choice of bounds can be seen not to have affected convergence.

We compute five sets of weighted grossing factors. The first is a set of 'univariate' weights which adjust only for the differential distribution of the age of the head of household. This provides a useful comparison point since these grossing factors allow some difference in spending but can be computed exactly by matching the sample cell frequency to that of the Census as described in the beginning of section III. Our second set of grossing factors adjusts

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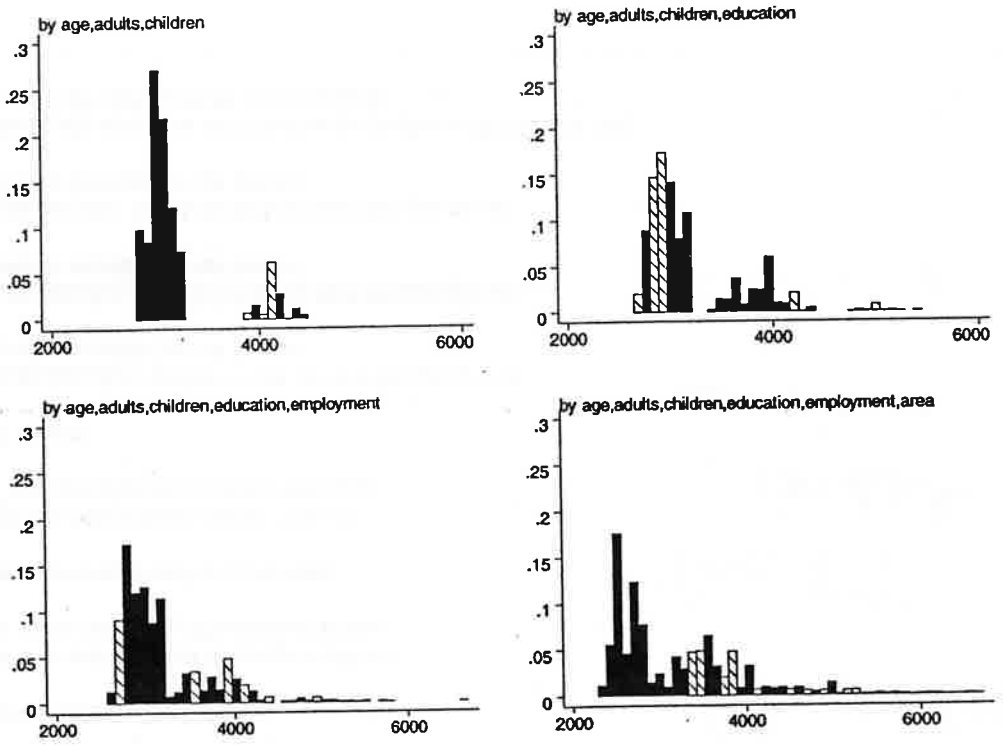
[8] Unfortunately the census reports for Great Britain do not give the actual proportions of household heads who are male and female. The available information summarizes characteristics of the head by household type (one adult (male), one adult (female), two adults (same sex), two adults (different sex), and so on). We estimate the proportion of households with a male head by assuming that the head is male in all mixed sex households (as the FES does) and in half of the same (unspecified) sex households.

for age of head of household and household size (number of adults and number of children). Our final three sets of grossing factors control for age and household size and add cumulatively, education, employment and area of residence. Histograms for the four multivariate sets of grossing factors are given in figure 3.1. The top left panel shows grossing factors computed simply by age and household size — the minimum required to begin to capture diversity in household spending. Since there are relatively few cells the grossing factors take only few values with reasonably high frequency. As we add successive demographic variables to the computation algorithm the dispersion of grossing factors increases but within a fairly confined range — even when we are grossing up by six variables, splitting the sample into over one thousand potential cells, the maximum weight given to a household is just over 6000 and the minimum is over 2000. In the next section we show the effect of using each of these five sets of weighted grossing factors on population estimates of spending.

Figure 3.1: Frequency distributions of grossing factors
by number of demographic variables



IV Applying differential grossing factors to 1991 FES spending data

As described in the previous section, we compute five sets of weighted grossing factors, controlling for a different number of dimensions of the population in which the FES is unrepresentative. In what follows we compare the effect of calculating population spending totals for the thirteen good model and the 28 goods and services where the FES is used to calculate National Accounts spending estimates, using each of the five sets of weighted grossing factors and compare the results with those obtained from uniform grossing. The results are reported in Tables 4.1 and 4.2 below. In all cases we report both the absolute value of the estimated annual population spending totals (in £ million) and the percentage change in using each set of differential grossing factors in comparison to uniform grossing. The results from applying differential grossing factors to the 70 good model are reported in Appendix C.

The results in Table 4.1 show that using differential grossing factors do make a difference to the estimates of population spending aggregates from the FES. This effect is greater for some goods and services than for others, reflecting the degree to which spending patterns differ systematically by household type. The results also show the effects of controlling for different dimensions in which the FES is unrepresentative. The effect on total spending estimates change as additional dimensions are added, but these effects vary across different goods, again reflecting differential spending patterns.

Table 4.1: Uniform versus differential grossing factors in estimating population spending totals from FES data

Key

Gr_fac1	age	Gr_fac4	age, no. ads, no.kids, educ, empl
Gr_fac2	age, no. adults, no.children	Gr_fac5	age, no.ads, no.kids, educ, empl, area of residence
Gr_fac3	age, no.adults, no.children, educ		

£ million

	uniform	Gr_fac1	Gr_fac2	Gr_fac3	Gr_fac4	Gr_fac5
Totexp	230210.1	230795.1	236040.1	238625.9	237599.4	237100.3
Foodin	40675.6	40848.2	41583.0	41711.7	41638.3	41626.6
Foodout	13121.1	13115.6	13543.1	13690.4	13595.5	13617.3
Alcohol	12631.3	12636.6	13211.6	13260.6	13222.1	13372.2
Tobacco	6002.2	6012.2	6271.0	6160.4	6181.6	6259.1
Fuel	14290.5	14332.0	14431.5	14473.7	14477.9	14466.1
HHGoods	23475.4	23528.0	23828.6	24017.1	23930.9	23784.5
HHServs	14044.1	14089.4	14103.4	14466.4	14381.5	14359.9
Cloth	18425.4	18457.9	18989.4	19139.7	19002.2	19048.2
PersGoods	13562.6	13614.8	13836.7	14079.0	13995.4	14007.4
Motor	39792.6	39869.8	41236.5	41761.7	41492.7	41009.8
Fares	6506.1	6499.1	6748.7	6963.7	6940.8	7078.8
LGoods	14060.0	14086.3	14414.4	14594.6	14520.2	14346.2
LServs	13622.5	13704.6	13841.8	14306.2	14219.8	14123.6

Percentages

	uniform	Gr_fac1	Gr_fac2	Gr_fac3	Gr_fac4	Gr_fac5
Totexp	230210.1	0.25%	2.53%	3.66%	3.21%	2.99%
Foodin	40675.6	0.42%	2.23%	2.55%	2.37%	2.34%
Foodout	13121.1	-0.04%	3.22%	4.34%	3.62%	3.78%
Alcohol	12631.3	0.04%	4.59%	4.98%	4.68%	5.87%
Tobacco	6002.2	0.16%	4.48%	2.64%	2.99%	4.28%
Fuel	14290.5	0.29%	0.99%	1.28%	1.31%	1.23%
HHGoods	23475.4	0.22%	1.50%	2.31%	1.94%	1.32%
HHServs	14044.1	0.32%	0.42%	3.01%	2.40%	2.25%
Cloth	18425.4	0.18%	3.06%	3.88%	3.13%	3.38%
PersGoods	13562.6	0.38%	2.02%	3.81%	3.19%	3.28%
Motor	39792.6	0.19%	3.63%	4.95%	4.27%	3.06%
Fares	6506.1	-0.11%	3.73%	7.03%	6.68%	8.80%
LGoods	14060.0	0.19%	2.52%	3.80%	3.27%	2.04%
LServs	13622.5	0.60%	1.61%	5.02%	4.38%	3.68%

The first set of differential grossing factors shown in Table 4.1 controls only for the age of the head of the household. This has a relatively small effect on the estimate of total spending - increasing or decreasing total spending by less than 0.5 per cent relative to the uniformly grossed figures in almost all cases. Looking at the final column which controls for all six dimensions, however, the effect of differential grossing can be seen quite clearly. In all cases, the effect of differential grossing is to increase the estimates of total spending relative to the uniformly grossed figures. In the case of fares, this increase is nearly nine per cent. The

smallest increase is for fuel and household goods. Total spending on alcohol increases by nearly six per cent as a result of differential grossing.

The figures in Table 4.1 can also be used to pick out the additional effects of correcting for different dimensions of the population. It is clear, for example, that controlling for household composition as well as age has a big effect on estimates of total spending for nearly all categories - increasing the estimates by at least one per cent compared to the effect of age only all goods except fares and household services and as much as four per cent for alcohol, tobacco and fares. The additional effect of including education is greatest for tobacco - where the estimate of total spending is reduced by two per cent - and estimates of spending on fares and household services which both rise. The additional effect of including the employment status of the household head is relatively small for all groups and the effect on the estimates of total spending less than one per cent. The final column shows the additional effect of including area of residence. This is seen to have a fairly large effect for some goods, particularly spending on fares which increases by two per cent. Spending on alcohol and tobacco increase by more than one per cent, while spending on motoring falls by one per cent.

In Table 4.2 we report the results from applying differential grossing factors to the 28 goods and services where FES data is used to estimate National Accounts spending totals. Again we report both estimated spending totals (in £ million) and the percentage change from the uniformly grossed figures. The results show that using differential grossing factors does make a difference to the estimates of total spending for this sub-set of commodities. In general, the effect of differential grossing is to increase the estimates of total spending, although in the case of three items - petcare, laundry services and private medical services, the effect is negative.

We also observe similar patterns in the 28 good case as in the broad groups of spending when we control for different dimensions of the population. The effect of correcting

only for age is small - increasing or decreasing the estimates of total spending by less than one per cent for almost all commodities. The effects of controlling for the unrepresentativeness of the FES in age and household composition are far larger - increasing the estimates of total spending by nearly six per cent in the case of taxis. Correcting for the employment status of the head has a smaller effect - typically changing the estimate of total spending by less than one per cent - while the additional effect of including education and area of residence is fairly large for some goods and services, particularly accommodation, books, laundry, private medicine, clothing repairs, theatre and social subscriptions in the case of education and private medicine, TV repairs, spectator sports, taxis and petcare in the case of area of residence.

Table 4.2: Uniform versus HBAI differential grossing factors in estimating population spending totals from FES data, 1991

Key

Gr_fac1	age	Gr_fac4	age, no. ads, no.kids, educ, empl
Gr_fac2	age, no. adults, no.children	Gr_fac5	age, no.ads, no.kids, educ, empl, area of residence
Gr_fac3	age, no.adults, no.children, educ		

£ millions per year

	uniform	Gr_fac1	Gr_fac2	Gr_fac3	Gr_fac4	Gr_fac5
Accom	8795.4	8860.8	8993.3	9198.8	9121.9	9164.3
Take	4205.2	4189.6	4377.7	4384.0	4359.7	4401.1
Rest	7011.3	7023.8	7200.3	7331.0	7284.1	7251.3
Book	1290.2	1293.7	1322.9	1376.9	1369.0	1360.9
News	2985.3	3002.2	3059.2	3073.6	3065.7	3057.5
Seeds	1336.2	1343.7	1356.1	1372.6	1364.0	1345.0
Drycln	190.4	190.3	191.3	196.5	196.1	197.6
Ent	947.9	947.9	989.6	995.5	988.3	983.7
Hairdr	2051.6	2059.9	2086.5	2109.0	2097.4	2104.5
Laundr	110.0	109.2	109.6	112.6	111.8	113.3
Primed	965.4	976.9	973.6	1001.1	994.4	960.6
Specs	1577.5	1570.8	1569.1	1583.4	1578.8	1570.2
Post	624.1	627.5	631.2	648.9	647.7	638.7
Phone	5577.2	5590.4	5637.3	5710.2	5686.4	5674.9
Shoerep	108.8	109.4	108.9	110.2	109.9	109.2
TVrep	163.5	163.3	164.1	163.5	162.3	168.3
Gasrep	374.9	377.6	389.3	397.5	395.0	393.8
Clotrep	334.8	338.2	348.0	363.8	360.5	364.2
Partip	1239.4	1243.1	1280.1	1291.7	1279.2	1274.0
Specsp	211.7	212.2	219.1	217.5	215.5	221.9
Theat	599.7	604.3	619.7	655.1	649.0	652.6
Str_ins	2001.2	2011.15	2018.2	2050.7	2040.1	2025.8
Con_ins	1453.7	1458.0	1460.3	1485.3	1479.6	1491.8
Clnmat	1956.6	1963.2	1993.6	1992.8	1986.9	1982.3
Cars	1120.7	1124.6	1151.1	1160.1	1154.7	1138.6
Taxis	946.6	945.0	1000.4	1006.4	1001.1	1026.5
Socsub	398.4	402.3	409.3	428.2	424.4	428.7
Petcare	2280.4	2289.5	2328.9	2331.0	2324.0	2256.1

Percentages

	uniform	Gr_fac1	Gr_fac2	Gr_fac3	Gr_fac4	Gr_fac5
Accom	8795.4	0.74%	2.25%	4.58%	3.71%	4.19%
Take	4205.2	-0.37%	4.10%	4.25%	3.67%	4.65%
Rest	7011.3	0.17%	2.69%	4.55%	3.89%	3.42%
Book	1290.2	0.27%	2.53%	6.71%	6.10%	5.47%
News	2985.3	0.56%	2.47%	2.95%	2.69%	2.41%
Seeds	1336.2	0.56%	1.48%	2.72%	2.08%	0.65%
Drycln	190.4	-0.05%	0.47%	3.20%	2.99%	3.78%
Ent	947.9	0.00%	4.39%	5.02%	4.26%	3.77%
Hairdr	2051.6	0.40%	1.70%	2.79%	2.23%	2.57%
Laundr	110.0	-0.72%	-0.36%	2.36%	1.63%	3.00%
Primed	965.4	1.19%	0.84%	3.69%	3.00%	-0.41%
Specs	1577.5	-0.42%	-0.53%	0.37%	0.08%	-0.46%
Post	624.1	0.54%	1.13%	3.97%	3.78%	2.33%
Phone	5577.2	0.23%	1.07%	2.38%	1.95%	1.75%
Shoerep	108.8	0.55%	0.09%	1.28%	1.01%	0.36%
TVrep	163.5	-0.12%	0.36%	0.00%	-0.73%	2.93%
Gasrep	374.9	0.72%	3.84%	6.02%	5.36%	5.04%
Clotrep	334.8	1.01%	3.94%	8.66%	7.67%	8.78%
Partip	1239.4	0.29%	3.28%	4.21%	3.21%	2.79%
Specsp	211.7	0.23%	3.49%	2.73%	1.79%	4.81%
Theat	599.7	0.76%	3.33%	9.23%	8.22%	8.82%
Str_ins	2001.2	0.49%	0.84%	2.47%	1.94%	1.22%
Con_ins	1453.7	0.29%	0.45%	2.17%	1.78%	2.62%
Clnmat	1956.6	0.33%	1.89%	1.85%	1.54%	1.31%
Cars	1120.7	0.34%	2.71%	3.51%	3.03%	1.59%
Taxis	946.6	-0.16%	5.68%	6.31%	5.75%	8.44%
Socsub	398.4	0.97%	2.73%	7.47%	6.52%	7.60%
Petcare	2280.4	0.39%	2.12%	2.21%	1.91%	-1.06%

Since the final set of grossing weights corresponds to demographic variables that were all significant in at least some spending equations, and they also lie in a feasible range suggesting the absence of numerical problems we choose them as our preferred set of weights. However, estimating population spending totals using the other four sets of grossing factors shows clearly the sensitivity of expenditure to adjusting for different dimensions of the population.[9]

[9] In principal the issue of sensitivity to different grossing factors could be explored more formally. However this would be a lengthy exercise, and the tables reported here show that population totals vary markedly as one moves from unifrom grossing to one dimension and then on to two dimensions. After that, however, differences between the totals implied be grossing factors taking account of an extra economic variable (such as employment status) are small.

V Updating the grossing factors

This section considers briefly the main categories of variables identified in the grossing factors and suggests possible data sources which could be used to obtain control totals by which to update the grossing factors between Census years.

a) Age of Head of Household

The age structure of the adult population should be relatively simple to determine. Census data could simply be 'aged' one year at a time to take account of known patterns of mortality by age and sex. Since a new census is available every ten years, no assumptions are needed about births when projecting an age distribution for adults. Immigration and emmigration could complicate the picture slightly, although ad hoc adjustments would be fairly straightforward.

Of course, knowing the age structure of the population is not the same as knowing the age distribution of household heads. Some sort of modelling (calibrated on the basis of a census, or possibly a series of censuses) would be needed to map the one distribution onto the other. A potential problem arises if the relationship between the age distribution of the adult population and the age distribution of household heads changes significantly from year to year.

b) Household Size (number of adults)

Data sources and comments under this heading are similar to those for the age distribution of heads of household. It would be necessary to examine trends in household size and the determinants of those trends (e.g. more divorce, more elderly people living longer etc.) and attempt to extrapolate from a census year.

c) Number of Children

This should in principle be the easiest control total to obtain. Child benefit data are produced on a quarterly basis and provides a distribution of family size for recipients. This data source is not subject to significant revision and should be available with a very short lag.

The only slight problem is that the data will be at the benefit unit rather than household level. For households with more than one benefit unit, both with dependent children, this will give a slight mismatch with the household picture. However, this is likely to be a rare situation and an ad hoc adjustment (possibly based on census patterns) should be adequate.

d) Type of Area (London/Metropolitan/Non-Metropolitan)

The regional breakdown used in the analysis above remains at a relatively high level of aggregation. It should be possible to obtain long-term historical data on trends in migration between different parts of the country and if, as seems plausible, these are relatively stable over time, a simple extrapolation from the census would be the best approach.

e) Education Level of Head of Household

From census data it would be possible to obtain a 1991 estimate of the distribution of qualification levels of household heads of different age and sex groups in order to provide a baseline estimate. The data could then be 'aged', taking account of the education levels of those recently leaving education, and of the typically low educational attainments of the elderly household heads who die each year. This would need to be done in a way which took account of the assumptions about patterns of household formation identified above.

f) Employment Status of Head of Household

The most regular and up-to-date source of control totals for employment status of heads of household would probably be the quarterly Labour Force Survey. It would be necessary to compare the LFS for 1991 with the corresponding census data to see whether any systematic adjustments would have to be made to LFS data in order to make it representative of the UK population. For example, if census data indicated that the LFS had below average response for a particular group, it would be necessary to reweight LFS estimates. However, provided the pattern of non-response did not vary significantly from year-to-year, LFS based

estimates should then be a reasonably good basis for predicting the employment status of heads of household.

LFS data also has the advantage that being a household survey there would be no need to make assumptions about the pattern of household formation. Indeed, LFS data could provide a rough guide as to whether the projections identified above about household size and composition were broadly accurate.

Conclusions

In this report we have shown that estimated population spending aggregates should take account of differences between households. Not only are certain types of households less likely to respond to the FES survey, but these non-response probabilities are correlated with differences in spending patterns. The net result is that simply applying uniform weights to the FES spending totals to achieve a population aggregate will yield a biased estimate of spending. For some items, or groups of items this bias may be over five percent.

Using a simple empirical model of household spending we have shown that all the dimensions of non-response identified by Foster (1995) are correlated with differences in spending for at least some commodities and hence should be controlled for in grossing up FES totals. The grossing factors required to do this were constructed using control totals computed from the 1991 census reports and these grossing weights were applied to 1991 FES data to produce new aggregates. In addition, for the goods in which FES information is the sole source of information on spending we have suggested that one might want to make some *ad hoc* imputations for the spending of the non-household sector (which is not covered within the sample frame of the FES). The relatively small size of this sector is such that these imputations are less important than adjusting unweighted totals to allow for non-response.

It is clear that the algorithm implemented in this paper for computing weighted spending aggregates is easily updated to be applied to other years, especially since it is not really necessary to re-estimate the extent of differences in spending patterns for every year of data. The important updating exercise is rather to obtain relevant control totals for non-census years. For some variables these can be obtained by applying inflow and outflow estimates to the most recent census information. For others it will require some extrapolation of the most recent census aggregates to the relevant year. Once the estimated control totals have been obtained it is simple to apply the calculation of grossing weights to the relevant control totals and FES data using the CALMAR macro or some other numerical method of solving non-linear equations.

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Appendix A: Grouping of goods in the Retail Price Index

RPI Group	*% > 0*	*£*	*Description*
FOOD IN			
Bread	0.99	5.16	bread
Cereals	0.74	1.84	flour, rice and other cereals, breakfast cereals, pasta
Biscuits	0.91	2.48	biscuits, cakes, pastries, fruit pies
Beef	0.64	2.87	beef and veal
Lamb	0.33	2.18	lamb
Pork	0.38	1.78	pork
Bacon	0.58	1.39	bacon and ham (uncooked)
Poultry	0.64	2.58	poultry
Other Meat	0.87	2.57	offal and other uncooked meat, cold meats and meat products, sausages, tinned and bottled meats, meat/poultry pies and pastries
Fish	0.67	2.00	uncooked fish and shellfish, processed fish, prepared fish products
Butter	0.42	0.76	butter
Oils & Fat	0.70	0.81	margarine, cooking fats and oils
Cheese	0.75	1.32	cheese
Eggs	0.66	0.71	eggs
Fresh Milk	0.69	2.48	fresh milk
Milk Products	0.77	2.37	yoghurt and milk desserts, other milk and cream
Tea	0.56	1.04	tea
Coffee	0.47	1.26	coffee, food drinks
SoftDrinks	0.71	1.73	carbonated drinks, fruit juice, drinks squash, mineral water
Sugar	0.63	0.77	sugar, jams, jellies, preserves
Sweets	0.70	1.83	sweets and chocolates
Potatoes	0.89	1.70	processed pots and products, raw potatoes, crisps
Veg	0.95	2.78	fresh veg and salad, processed and frozen veg, pulses dried and processed
Fruit	0.89	2.92	fresh fruit, processed fruit (excl dried), dried fruits and nuts
Other Food	0.94	1.70	ice-cream and sorbets, diet foods, baby food, pickles/sauces/flavourings, soup, quiche, flans, pizzas, veg protein/rissoles etc, pastry, mixes for cakes, other convenience food, meat dishes - ready prepared, veg dishes - ready prepared, prepared fish dishes, food - nos, food - other
FOOD OUT			
Restaurant	0.67	8.96	hot food eaten on premises, cold food eaten on premises
Canteen	0.42	3.91	meals bought & eaten at work, school meals
Takeaway	0.68	5.61	hot t/a meals eaten at home, cold t/a meals eaten at home, hot food eaten off premises, cold food eaten off premises, confect eaten off premises, ice-cream eaten off premises, soft drinks drunk off premises, hot food from other outlets, cold food from other outlets, confect from other outlets, ice-cream from other outlets, soft drinks from other outlets
ALCOHOL			
Beer	0.57	10.6	beer and lager, cider
Wine	0.35	6.09	unfortified still wine, champagne and sparkling wine, fortified wine
Spirits	0.33	7.76	spirits, liqueurs, alcohol not specified
TOBACCO			
Cigarettes	0.39	12.4	cigarettes
Other Tobacco	0.06	5.09	pipe tobacco, cigars
HOUSING			
Repair	0.39	8.51	central heating repairs - second dwelling, central heating repairs - main dwelling, house maintenance - main dwelling, house maintenance - second dwelling
DIY	0.25	15.4	other materials inc equip hire, doors, baths and other fittings, tools, paint, wallpaper and timber
FUEL			
Solid Fuel	0.05	13.1	coal and coke
Electricity	0.99	6.14	2nd dwelling - elec account, electricity - slot meter, elec - amount paid in last ac, elec - last payment board budget scheme, elec - last slot meter rebate

Gas	0.77	6.33	second dwelling - gas account, gas - slot meter, gas - amount paid in last ac, gas - last payment board budget scheme, gas - last slot meter rebate
Oil & other	0.09	6.30	calor gas, paraffin, other, oil for central heating last qtr
HOUSEHOLD GOODS			
Furniture	0.20	27.7	furnit inc beds & mattresses
Furnishings	0.23	15.9	soft floor coverings, hard floor coverings, bedding excl beds & matt's, curtains, cushions etc
Electrical Applicances	0.19	14.8	elec & gas/elec cookers, washmachs & tumble driers, elec fridge/freezer, dishwashers, microwaves etc, electrical tools, minor elec equip, repairs to gas/elec appl, rental/hire of elec hh equip
Household Equipment	0.38	5.78	gas cookers, other gas appliances, china, glass, pottery etc, garden tools and accessories, garden equipment, kitchen utensils and equip, other household hardware, baby equip, hh goods nos
Consumables	0.94	4.40	elec consumables, toilet paper, personal stationery, disinfectants, polishes, detergents, kitchen disposbles
Petcare	0.41	4.80	petfood, pet purchases and accessories
HOUSEHOLD SERVICES			
Post	0.46	1.16	postage and poundage
Phone	0.87	5.49	2nd dwelling - telephone acc, phone coin and other payment, mobile phone ac payment, phone budget ac payment, phone - hhold share of account, phone budget account charge
DomServs	0.31	7.39	childcare payments, domestic help, repairs to footwear, repairs to personal goods, cleaning and dyeing, laundry, laundrette, moving house
Fees and Subs	0.83	5.31	contents ins - last payment, bank charges - last 3 mths, stamp duty, certs, licences, subs - tu and prof, subs to sports and social clubs, subs - leis activities, other subs eg political parties, contract catering for weddings, funeral expenses, legal fees - banks, legal fees - solicitors, court fines & prof fees
CLOTHING			
Menswear	0.20	16.5	mens outerwear
Womenswear	0.31	16.8	womens outerwear
Kidswear	0.17	10.2	boys outerwear, girls outerwear, infants outerwear
Other Clothes	0.51	5.19	mens underwear, womens underwear, childrens underwear, mens accessories, womens accessories, childrens accessories, haberdashery, clothing materials
FootWear	0.26	11.0	mens footwear, womens footwear, childrens footwear, footwear nos
PERSONAL GOODS AND SERVICES			
Personal Articles	0.28	10.1	glasses, lenses, optical accessories, jewellery, watches, leather and travel goods, personal goods nos, decorative goods
Chemists Goods	0.85	4.97	medical goods - non NHS, NHS prescription charges, toilet requisites, toilet soap, toiletetries, cosmetics, hair products - shampoo etc, baby toiletries
Personal Services	0.51	9.03	NHS services - fees, private health service fees, hairdressing, beauty fees
MOTORING			
Motor Purchase	0.22	73.2	new car/van - loan or hp, 2nd hand car/van - loan or hp, car leasing payments, new/2ndhand m'cycle loan/hp, cost of new car/van outright, cost of 2ndhand car/van, cost of motorcycle outright
Maintain	0.40	13.0	m'cycle repairs, spare parts, motor cycle accessories, car/van repairs/ servicing, car/van spare parts, car/van accessories and fitting, garage rent, AA, RAC subs, driving lessons, anti freeze, battery, parking fees, tolls and permits
Petrol Oil	0.61	13.9	petrol, diesel oil, other motor oils
Tax and Ins	0.64	7.39	road tax - amount last year, insurance - amount last year, road tax - refund last year
FARES			
Rail Fares	0.15	9.66	combined fare non-seaaon, rail/ tube other than season, combined sacaon ticket, rail/tube season ticket
Bus Fares	0.39	3.21	bus/coach non-season ticket, bus/coach season ticket
Other Fares	0.29	9.99	purchase of bicycles, boats etc, accs's and repairs of bikes etc, air fares within UK, air fares international, water travel, taxi fares, hire of self-drive cars, other personal travel, school travel - last week
LEISURE GOODS			
Audio Visual Gds	0.11	27.9	telephone purchase, mobile phone purchase, answer/fax machs,

			modems, tv sets, satellite dish purchase, satellite dish installation, TV, audio repair, video recorders, home computers/ printers, audio equipment, CD players, musical instruments
Records	0.27	5.79	records/cds/cassettes/software, cassette cases, record tokens, video cassettes purchase/rental
Toys	0.31	8.27	toys/hobbies/games (tv etc), photo and optical goods, sports goods and equipment
Books	0.90	4.08	books, newspapers, magazines and periodicals
Gardening	0.30	4.06	plants, seeds, fertilizers
LEISURE SERVICES			
TV Licences	0.93	2.40	second dwelling - tv licence, tv rental, slot meter, satellite tv channels subs, cable tv connection/subs, tv licence - amount last year
Entertainment	0.66	14.3	cinemas, live entertainment, clubs/discos/bingos admission, social events inc car boot sales, participant sports excl subs, spectator sports, charitable gifts, cash gifts, ed - amount paid last week, leisure class fees, children - educ fees last qtr, money sent abroad, nursery, creche, playschools

Appendix B: Multivariate demand analysis - 70 good model

	a2	a3	a4	a5	2ad	3+ad	1kid	2+kid	ed1	ed2	emp	self	lond	met
bread	0.30*	0.53*	0.44*	0.34*	0.73*	1.58*	-0.87*	-0.59*	0.07	0.03	0.07*	0.13*	-1.20	0.28
cereal	0.11*	0.33*	0.30*	0.27*	0.42*	0.92*	-1.34*	-0.89*	-0.55*	-0.33*	-0.00	0.07	2.37*	-1.50
bisc	0.49*	0.89*	1.21*	1.16*	1.18*	2.18*	-1.35*	-0.73*	0.04	0.10	0.50*	0.55*	-0.49	-0.60
beef	0.37*	0.698	0.49*	0.27*	1.14*	2.21*	-0.30*	-0.13	0.42*	0.39*	0.19*	0.53*	-0.61	1.17
lamb	0.22*	0.54*	0.51*	0.56*	0.45*	0.85*	-0.31*	-0.14	-0.03	0.02	-0.05	0.07	5.77*	2.48*
pork	0.16*	0.348	0.34*	0.17*	0.35*	0.76*	-0.20*	-0.00	0.22*	0.21*	0.16*	0.18*	0.54	-0.89
bacon	0.20*	0.46*	0.45*	0.41*	0.44*	0.85*	-0.07	-0.05	0.09*	0.04	0.13*	0.25*	-0.49	2.11*
poult	0.25*	0.66*	0.51*	0.36*	0.76*	1.53*	-0.83*	-0.36*	-0.17*	0.08	0.30*	0.46*	4.16*	1.03
othm	0.45*	0.80*	0.83*	0.68*	1.02*	2.28*	-0.89*	-0.32*	0.34*	0.16	0.23*	0.28*	-2.21*	0.39
fish	0.32*	0.91*	0.99*	0.94*	0.81*	1.05*	-0.26*	-0.02	-0.50*	-0.36*	0.10	0.06	3.97*	0.54
butter	0.06*	0.158	0.20*	0.23*	0.15*	0.32*	-0.10*	-0.00	-0.02	-0.03	-0.00	0.08*	0.88	0.09
fats	0.10*	0.21*	0.21*	0.13*	0.28*	0.58*	-0.33*	-0.23*	-0.01	-0.03	0.00	0.01	0.39	-0.49
cheese	0.28*	0.38*	0.34*	0.26*	0.48*	0.87*	-0.33*	-0.12*	-0.37*	-0.24*	0.23*	0.28*	0.06	-5.88*
eggs	0.05*	0.19*	0.12*	0.11*	0.17*	0.40*	-0.23*	-0.12*	-0.00	0.00	-0.06*	-0.03	3.10*	0.65
milkf	0.14	0.30*	0.42*	0.67*	0.60*	1.70*	-1.58*	-0.72*	0.14	-0.04	-0.22*	0.06	-1.16	-0.69
milkp	0.51*	0.70*	0.73*	0.47*	0.87*	1.34*	-1.10*	-0.44*	-0.58*	-0.24*	0.47*	0.56*	-1.26	-2.99*
tea	0.12*	0.27*	0.26*	0.23*	0.28*	0.52*	-0.13*	-0.11*	0.09*	0.03	-0.09*	0.00	1.80	1.43
coffee	0.18*	0.32*	0.22*	0.16*	0.22*	0.42*	-0.11*	-0.09*	-0.17*	-0.13*	0.10*	0.16*	-0.85	-0.09
softd	0.08	0.03	-0.07	-0.12	0.44*	1.40*	-1.24*	-0.56*	-0.22*	-0.06	0.27*	0.28*	4.58*	-0.79
sugar	0.09*	0.29*	0.35*	0.37*	0.22*	0.44*	-0.26*	-0.20*	-0.03	-0.04	-0.07*	-0.02	-1.14	-2.38*
sweets	0.10	0.14	0.41*	0.29*	0.58*	1.34*	-0.84*	-0.43*	-0.23*	-0.08	0.38*	0.31*	-1.95	-0.48
pots	0.07	0.03	-0.03	-0.15*	0.61*	1.50*	-1.33*	-0.59*	0.44*	0.32*	0.18*	0.18*	-1.53	-4.72*
vegs	0.45*	0.898	0.60*	0.29*	1.24*	2.39*	-1.06*	-0.57*	-0.88*	-0.47*	0.26*	0.57*	5.21*	-1.82
fruit	0.59*	1.388	1.62*	1.39*	1.19*	2.13*	-1.31*	-0.63*	-1.86*	-1.03*	0.52*	0.67*	5.56*	-3.71*
othfd	0.01	0.10	-0.09	-0.16	1.68*	2.98*	-1.61*	-0.26	-0.38	-0.07	0.97*	1.21*	1.67	-0.66
rest	-0.31	0.46	-0.49	-1.05	3.05*	6.42*	1.31*	0.66	-4.51*	-2.18*	2.99*	3.10*	3.23*	-3.27*
cant	-0.10	-0.44*	-0.71*	-0.59*	0.36*	1.93*	-1.26*	-0.87*	-0.18	-0.12	1.54*	0.27*	3.31*	1.19
take	-0.79*	-2.42*	-2.89*	-2.61*	1.07*	5.16*	-0.29	0.08	0.04	0.10	1.81*	2.58*	4.74*	2.54*
beer	-0.10	-2.49*	-4.16*	-4.79*	2.36*	11.1*	3.21*	1.09*	2.69*	1.73*	2.63*	2.34*	-1.41	4.54*
wine	-0.16	0.20*	-0.65	-0.61	1.73*	1.76*	0.64	0.54	-3.54*	-2.09*	0.12	1.07	1.64	-0.77
spirit	-0.23	-0.54	-0.87*	-0.81*	1.52*	3.85*	1.69*	0.09	-0.61*	-0.18	1.36*	1.64*	3.56*	0.87
tobac	0.90*	-0.19	-2.82*	-4.17*	1.75*	7.03*	0.38	0.90*	4.22*	2.44*	-0.45	-0.35	0.56	4.06*

	a2	a3	a4	a5	2ad	3+ad	1kid	2+kid	ed1	ed2	emp	self	lond	met
repair	1.27	1.80*	2.41*	2.64*	1.22*	1.49*	1.07	1.27	-6.42*	-4.95*	0.77	3.62*	1.58	0.47
diy	0.69	1.21	0.84	-0.21	2.23*	2.67*	0.02	-0.21	-1.30	-1.48	2.31*	3.49*	-2.24*	-0.26
elec	0.42*	0.948	0.21	0.34	0.87*	2.51*	-1.85*	-0.62*	-0.55*	-0.02	-0.29*	0.43	-0.63	0.72
gas	1.08*	2.02*	2.23*	2.20*	1.86*	2.59*	-1.88*	-0.55*	-1.36*	-0.53*	0.09	0.84*	-1.16	-0.32
furnit	-0.59	-1.03	-2.02	-2.50*	2.99*	4.63*	0.53	1.20	-1.23	0.63	1.61*	4.32*	2.18*	0.41
furnis	0.40	0.68	-0.23	-1.42*	2.63*	1.98*	1.04	0.90	-1.84*	-0.89	0.19	1.33	0.78	0.36
applia	0.52	0.61	0.82	0.05	1.70*	1.95*	-0.12	0.25	-1.43*	-0.40	0.60	-0.05	-1.57	-2.25*
equip	0.79*	1.37*	0.93*	1.20*	1.64*	2.25*	-0.15	0.65	-1.57*	-0.87	0.86*	0.66*	-0.73	-2.29*
consum	0.31*	1.08*	1.13*	0.78*	1.73*	3.81*	-2.32*	-0.84*	-1.33*	-0.67*	1.20*	1.41*	1.76	-2.74*
pets	0.75*	0.38*	-0.20	-0.51	0.93*	1.50*	0.69*	0.28	-0.14	0.00	0.48*	1.91	-5.16*	-4.58*
post	0.02	0.32*	0.48*	0.43*	0.18*	0.26*	-0.10*	0.05	-0.66*	-0.42*	0.04	0.10	0.52	-3.71*
phone	0.79*	1.03*	0.95*	0.47*	1.07*	2.20*	-1.08*	-0.74*	-2.59*	-1.35*	1.03*	0.02*	4.06*	-2.32*
domsv	0.67	1.30	2.07*	3.55*	0.61*	0.22*	-2.05*	1.44*	-4.35*	-3.09*	1.20*	2.00*	2.20*	-0.02
subs	0.64	1.77	1.49	1.49	2.09*	1.40*	-0.45	-0.84	-4.45*	-4.38*	3.03*	1.87*	1.26	-1.35
mwear	0.49	-0.42	-0.76	-0.89*	1.67*	5.15*	1.02*	1.52*	-1.61*	-0.82	1.58*	1.36*	1.66	0.61
wwear	-0.44	0.168	-0.06	-0.82	2.47*	6.85*	0.76	0.24	-2.27*	-0.18	2.94*	1.63*	-1.37	-0.11
kwear	0.68*	0.73*	1.05*	0.92*	0.30*	0.31	-4.98*	-1.52*	-0.76*	-0.72	0.66*	1.13	-0.09	1.51
cloth	0.09	0.55	0.75*	0.21	1.31*	2.96*	-0.85*	-0.17	-0.77*	-0.00*	1.05*	0.47	0.78	0.61
fwear	0.33	-0.12*	-0.19	-0.75*	1.04*	3.25*	-1.67*	-0.88*	-0.15	-0.25	0.90*	0.74	2.20*	1.22
partic	-0.00	0.94	0.77*	1.21*	1.76*	4.30*	0.05	0.43	-1.96*	-0.85	1.32*	1.14*	-0.38	1.64
chem	-0.43	-0.35*	-0.51*	-0.67*	2.21*	4.43*	-1.68*	0.26	-1.20*	-0.36	1.37*	0.81*	2.71*	-0.79
pserv	1.67*	2.76*	4.04*	5.31*	2.01*	1.88*	-2.35*	1.11	-5.77*	-3.07	1.51*	2.55	1.62	-1.67
purc	-1.96	-0.80	-2.74	-4.15	8.41*	22.3*	2.29	1.34	-9.45*	-2.96*	9.57*	4.96	-0.35	-1.19
maint	0.25	0.60	0.67	-0.42	3.48*	6.68*	0.44	-0.23	-4.55*	-1.99	2.07*	0.04*	-2.94*	-0.60
petrol	0.47	0.82*	-1.45*	-2.68*	4.82*	11.2*	0.70	0.18	-2.81*	-1.08	3.79*	2.15*	-5.55*	-6.16*
taxins	-0.29	-0.13	-0.55*	-1.39*	2.79*	6.57*	0.75*	0.29	-2.15*	-1.03*	1.87*	2.08	0.30	-5.76*
rail	-1.04*	-1.07*	-1.45*	-1.36*	0.59*	2.03*	0.64*	0.20	-2.51*	-1.55*	0.68*	0.22*	10.9*	-0.81
bus	0.19	0.16	-0.21	-0.50*	0.12	2.01*	-0.30*	0.06	0.37*	0.19*	0.04	-0.60*	0.93	7.43*
othfar	-0.55	-0.19	-0.58	-0.35	0.98*	3.14*	-0.10*	0.19	-4.52*	-4.21	1.37*	1.54	2.77*	0.18
audio	0.96	-1.21	-2.32	-3.05*	0.67	2.80*	1.59	-0.83	-2.03	-1.74*	0.57	0.92	-2.48*	-1.84
records	0.17	-0.72*	-0.84*	-0.84*	0.51*	2.52*	0.16	-0.01	-0.64*	-0.18	0.86*	0.44*	0.73	-0.42
books	0.55*	1.49*	1.71*	1.26*	1.54*	3.28*	-0.23	-0.10	-2.38*	-1.62	0.83*	0.74*	1.72	-1.98*
toys	0.09	0.10	0.09	-0.29	1.08*	1.97*	-2.09	-0.68	-0.85*	-0.34*	1.56*	1.60*	-0.21	0.40
garden	0.22	0.70*	0.63*	0.29*	0.91*	0.97*	0.30*	0.20	-0.77*	-0.26	0.40*	0.63	-1.81	-1.80
tvlic	0.29*	0.32*	0.13	0.04	0.48*	1.10*	-0.22*	-0.02	0.17*	0.21*	0.01	-0.16*	-1.05	1.39
enter	1.65	7.45*	9.65*	7.97*	3.71*	7.32*	-9.05*	-5.24*	-17.3*	-10.3*	5.92*	6.37*	1.90	-2.76*

Appendix C: The effect of differential grossing

Key

Gr_fac1	age	Gr_fac4	age, no. ads, no.kids, educ, empl
Gr_fac2	age, no. adults, no.children	Gr_fac5	age, no.ads, no.kids, educ, empl, area of residence
Gr_fac3	age, no.adults, no.children, educ		

£ millions

	uniform	Gr_fac1	Gr_fac2	Gr_fac3	Gr_fac4	Gr_fac5
bread	2074.6	2083.0	2120.9	2118.9		2117.9
cereal	1251.1	1255.7	1270.3	1285.6	1286.0	1285.2
bisc	2634.4	2647.9	2694.6	2694.5	2684.7	2681.2
beef	2147.2	2158.6	2215.5	2202.9	2197.5	2202.4
lamb	835.7	843.1	862.6	864.9	867.3	883.5
pork	796.7	801.3	821.7	815.4	813.3	811.7
bacon	945.4	952.0	974.5	972.4	971.2	974.8
poult	1921.0	1929.8	1964.1	1968.7	1963.6	1971.8
othm	2609.2	2621.7	2681.7	2673.4	2669.5	2670.2
fish	1553.5	1564.3	1580.2	1595.1	1592.9	1603.2
butter	368.4	370.8	379.1	379.9	380.0	380.1
fats	662.4	665.6	679.2	679.9	680.2	679.3
cheese	1168.8	1174.3	1193.7	1204.7	1201.5	1190.1
eggs	545.1	547.7	557.8	557.8	559.2	560.5
milkf	2014.0	2020.9	2063.6	2060.8	2064.3	2061.0
milkp	2124.6	2133.7	2154.3	2170.1	2160.7	2146.2
tea	674.0	678.1	690.8	688.2	688.7	691.8
coffee	693.9	698.1	708.1	713.1	711.3	709.8
softd	1440.9	1443.0	1479.8	1486.7	1482.0	1484.0
sugar	562.4	566.5	576.1	576.8	578.0	574.8
sweets	1484.3	1487.8	1519.7	1527.2	1520.5	1515.4
pots	1756.3	1758.5	1794.2	1782.6	1780.0	1769.1
vegs	3080.6	3093.3	3146.0	3170.9	3169.9	3170.5
fruit	3026.7	3044.0	3084.2	3136.5	3126.9	3119.6
othfd	4303.2	4307.2	4369.3	4383.7	4368.9	4371.0
rest	7011.3	7023.8	7200.3	7331.0	7284.1	7251.3
cant	1904.5	1902.1	1964.9	1975.3	1951.5	1964.7
take	4205.2	4189.6	4377.7	4384.0	4359.7	4401.1
beer	7088.7	7087.6	7517.9	7449.3	7421.4	7528.5
wine	2513.0	2516.4	2533.2	2629.5	2636.5	2653.7
spirit	3029.5	3032.6	3160.4	3181.8	3164.1	3189.8
tobac	6002.2	6012.2	6271.0	6160.4	6181.6	6259.1

Key

Gr_fac1	age	Gr_fac4	age, no. ads, no.kids, educ, empl
Gr_fac2	age, no. adults, no.children	Gr_fac5	age, no.ads, no.kids, educ, empl, area of residence
Gr_fac3	age, no.adults, no.children, educ		

	uniform	Gr_fac1	Gr_fac2	Gr_fac3	Gr_fac4	Gr_fac5
diy	4570.4	4584.3	4630.6	4678.8	4662.5	4621.1
elec	7091.8	7106.7	7171.7	7181.9	7188.6	7186.6
gas	7198.7	7225.2	7259.7	7291.8	7289.2	7279.5
furnit	6374.2	6368.5	6471.4	6499.9	6481.3	6522.8
furnis	4200.7	4207.1	4210.4	4255.9	4246.8	4268.8
applia	3232.3	3240.7	3264.4	3297.1	3284.8	3212.7
equip	2569.9	2588.9	2630.8	2671.1	2651.5	2599.2
consum	4817.6	4833.0	4922.4	4961.8	4942.2	4924.6
pets	2280.4	2289.5	2328.9	2331.0	2324.0	2256.1
post	624.1	627.5	631.2	648.9	647.7	638.7
phone	5577.2	5590.4	5637.3	5710.2	5686.4	5674.9
domsv	2679.0	2692.5	2668.1	2793.2	2775.5	2791.2
subs	5163.8	5178.9	5166.6	5313.9	5271.8	5255.0
mwear	3840.4	3845.7	4020.5	4068.9	4041.3	4063.6
wwear	6044.5	6056.7	6271.3	6323.0	6263.2	6232.9
kwear	2062.3	2066.1	2035.9	2058.0	2047.8	2068.4
cloth	3097.9	3106.5	3183.7	3203.6	3179.5	3185.8
fwear	3380.0	3382.6	3477.7	3486.06	3470.1	3497.3
partic	3263.2	3281.5	3406.8	3460.5	3440.6	3473.7
chem	4950.4	4950.2	5054.7	5088.6	5060.9	5060.0
pserv	5348.8	5383.0	5375.1	5529.8	5493.8	5473.6
purc	18394.7	18419.8	19103.5	19378.6	19227.8	19024.5
maint	6010.2	6027.1	6194.1	6307.3	6271.7	6208.9
petrol	9869.5	9896.2	10218.5	10294.6	10236.7	10079.5
taxins	5518.1	5526.5	5720.3	5781.1	5756.4	5696.8
rail	1658.0	1646.8	1713.9	1793.9	1782.1	1829.0
bus	1453.1	1457.9	1540.0	1529.6	1535.0	1588.1
othfar	3394.8	3394.3	3494.6	3640.1	3623.6	3661.5
audio	3499.5	3497.7	3599.2	3652.2	3644.6	3509.1
records	1865.9	1864.3	1956.2	1973.6	1958.1	1954.4
books	4275.5	4295.9	4382.2	4450.6	4434.7	4418.4
toys	3000.3	3001.2	3037.2	3061.1	3034.7	3036.0
garden	1418.7	1426.9	1439.4	1456.9	1448.0	1428.0
tvlic	2592.7	2598.4	2628.6	2622.7	2621.9	2626.5
enter	11029.8	11106.2	11213.1	11683.5	11597.8	11497.0

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