Appendix

A Computation of elasticities

From Banks et al. (1997), expenditure and price elasticities from a single stage demand system, denoted by E_i^x and E_{ij}^u respectively, are given as below:

$$E_i^x = \frac{\mu_i}{w_i} + 1 \tag{A1}$$

$$E_{ij}^u = \frac{\mu_{ij}}{w_i} - \delta_{ij} \tag{A2}$$

Edgerton (1997) illustrates the relationship between demand elasticities in different levels of multistage budgeting process. Unconditional expenditure elasticities can be combined as follow:

$$e_{i(p)}^x = E_i^x \times E_p^x \tag{A3}$$

where E_p^x is the first-stage expenditure elasticity of demand for outlet p and E_i^x is the second-stage expenditure elasticity of demand for food group i in outlet p. Substituting (A1) into (A3):

$$e_{i(p)}^x = \left(\frac{\mu_i}{w_i} + 1\right)\left(\frac{\mu_p}{w_p} + 1\right) \tag{A4}$$

Similarly, the uncompensated price elasticity of demand for food group i in outlet p in respective to change to price change in food group j in outlet p is given as

$$e_{ij(p)}^u = E_{ij}^u + E_i^x w_j [1 + E_{pp}^u] \tag{A5}$$

$$e_{ij(p)}^u = \frac{\vartheta_{ij}}{w_i} - \delta_{ij} + w_j\left(\frac{\mu_i}{w_i} + 1\right)\left[1 + \left(\frac{\vartheta_{pp}}{w_p} - \delta_{pp}\right)\right] \tag{A6}$$

As δ_{pp}=1, after rearranging the terms

$$e_{ij(p)}^u = \left(\frac{\vartheta_{ij}}{w_j} - \delta_{ij}\right) + \left(\frac{w_j \vartheta_{pp}}{w_p}\right)\left(\frac{\mu_i}{w_i} + 1\right) \tag{A7}$$

B The estimation process of demand elasticities

Step 1	Estimate the adjusted out-of-home expenditure as described in section 3.3.
Step 2	Estimate eq. 4 to obtain CDP and PDF for the probability of observing a positive purchase in each outlet
Step 3	Estimate QUAIDS for the allocation of out-of-home expenditure across outlets using 3SLS
Step 4	Estimate the adjusted expenditure for restaurants as described in section 3.3.
Step 5	Estimate eq. 4 to obtain CDP and PDF for the probability of observing a positive purchase of each food group from restaurants
Step 6	Estimate QUAIDS for the allocation of restaurant expenditure across food groups using 3SLS
Step 7	Repeat steps 4-6 for the other three outlets
Step 8	Calculate elasticities from the above QUAIDS parameters using eq. 9 and 10
Step 9	Repeat steps 1 to 8 with 1000 bootstrap replications

Note: Steps 1 to 3 are the estimation procedure for the first stage demand while steps 4 to 7 estimate the demand models in the second stage. Step 8 combines the results from both stages.

C Demand elasticities for food and beverages across out-of-home outlets in Great Britain

	Restaurants		**Fast-food outlets**		**Food retail**		**Other outlets**	
	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
First Stage: Out-of-home demand across outlets								
YED	1.151	0.051	0.787	0.096	0.650	0.091	1.299	0.109
PED in response to price changes in								
Restaurants	-0.749	0.159	-0.361	0.166	0.034	0.153	-0.056	0.181
Fast-food outlets	-0.295	0.109	-0.765	0.195	0.376	0.165	-0.130	0.177
Food retail	-0.069	0.109	0.338	0.156	-1.426	0.249	0.191	0.194
Other outlets	-0.008	0.089	-0.039	0.127	0.295	0.145	-1.245	0.183
Second Stage: Out-of-home demand across food groups within each outlet								
YED								
Main meals	1.425	0.111	0.779	0.110	0.727	0.237	1.741	0.320
Quick meals	1.059	0.129	0.909	0.169	0.663	0.103	1.475	0.150
Sugary drinks	0.687	0.184	0.651	0.215	0.514	0.113	1.275	0.216
Non-sugary drinks	0.993	0.328	0.696	0.333	0.569	0.133	1.331	0.252
Sweet snacks	1.009	0.260	0.564	0.438	0.576	0.094	0.596	0.172
Hot beverages	1.287	0.121	0.387	0.238	0.739	0.130	1.358	0.174
Others	1.938	0.713	1.254	1.392	0.700	0.117	0.743	0.233
PED for main meals in response to price changes in								
Main meals	-1.383	0.201	-0.691	0.131	-0.722	0.574	-0.989	0.558
Quick meals	0.095	0.120	-0.064	0.141	-0.229	1.037	-0.292	0.743
Sugary drinks	-0.011	0.099	0.032	0.089	0.009	0.981	0.079	0.617
Non-sugary drinks	-0.038	0.133	0.007	0.077	-0.033	0.803	-0.103	0.653
Sweet snacks	0.100	0.133	0.048	0.079	0.013	1.008	-0.017	0.729
Hot beverages	0.308	0.154	-0.101	0.084	-0.170	0.849	-0.067	0.655
Others	0.143	0.163	0.005	0.096	-0.113	0.924	-0.013	0.628
PED for quick meals in response to price changes in								
Main meals	0.261	0.241	-0.173	0.192	-0.034	0.178	-0.060	0.140
Quick meals	-1.327	0.242	-0.728	0.264	-1.256	0.336	-1.195	0.204
Sugary drinks	0.296	0.182	-0.080	0.156	0.041	0.304	-0.022	0.160
Non-sugary drinks	-0.178	0.207	0.029	0.142	0.108	0.237	0.103	0.158
Sweet snacks	0.133	0.208	-0.082	0.143	-0.019	0.332	-0.038	0.170
Hot beverages	0.079	0.200	0.212	0.143	-0.221	0.229	-0.084	0.160
Others	-0.006	0.252	0.029	0.175	-0.100	0.305	-0.021	0.147
PED for sugary drinks in response to price changes in								
Main meals	0.036	0.379	0.283	0.276	-0.043	0.329	0.150	0.352

Quick meals	0.589	0.354	-0.174	0.386	0.122	0.593	-0.077	0.432
Sugary drinks	-1.502	0.520	-0.380	0.400	-1.204	0.584	-1.658	0.373
Non-sugary drinks	-0.169	0.324	-0.339	0.274	-0.420	0.466	0.207	0.388
Sweet snacks	-0.104	0.335	0.188	0.242	-0.288	0.632	0.298	0.413
Hot beverages	0.368	0.391	-0.268	0.241	0.349	0.413	-0.301	0.375
Others	0.084	0.413	-0.046	0.276	0.135	0.560	0.173	0.353
PED for non-sugary drinks in response to price changes in								
Main meals	-0.175	0.527	0.185	0.450	-0.098	0.410	-0.196	0.429
Quick meals	-0.592	0.460	0.200	0.586	0.264	0.759	0.302	0.578
Sugary drinks	-0.326	0.497	-0.553	0.512	-0.500	0.696	0.246	0.501
Non-sugary drinks	-1.145	0.532	-0.133	0.514	-0.845	0.554	-0.570	0.524
Sweet snacks	0.513	0.449	0.044	0.401	0.093	0.775	-0.509	0.487
Hot beverages	1.152	0.517	-0.368	0.435	-0.043	0.561	-0.317	0.484
Others	-0.113	0.615	-0.121	0.476	-0.265	0.722	-0.201	0.450
PED for sweet snacks in response to price changes in								
Main meals	0.544	0.425	0.562	0.455	0.020	0.182	-0.013	0.250
Quick meals	0.305	0.368	-0.325	0.554	0.031	0.346	0.142	0.366
Sugary drinks	-0.127	0.347	0.301	0.507	-0.163	0.322	0.217	0.327
Non-sugary drinks	0.323	0.381	0.043	0.503	0.031	0.267	-0.266	0.304
Sweet snacks	-1.010	0.499	-1.076	0.463	-1.265	0.356	-1.110	0.317
Hot beverages	-0.513	0.413	-0.212	0.492	-0.011	0.244	0.122	0.313
Others	-0.237	0.536	-0.010	0.632	0.015	0.317	-0.083	0.266
PED for hot beverages in response to price changes in								
Main meals	0.399	0.185	-0.190	0.296	-0.020	0.286	0.016	0.270
Quick meals	0.020	0.151	0.680	0.363	-0.405	0.593	-0.119	0.325
Sugary drinks	0.085	0.140	-0.179	0.279	0.195	0.554	-0.150	0.275
Non-sugary drinks	0.180	0.165	-0.183	0.294	-0.010	0.446	-0.123	0.275
Sweet snacks	-0.156	0.151	-0.222	0.273	-0.120	0.593	0.012	0.305
Hot beverages	-1.175	0.200	-0.557	0.286	-1.104	0.435	-0.959	0.332
Others	-0.129	0.187	-0.028	0.323	-0.022	0.536	0.055	0.285
PED for other food in response to price changes in								
Main meals	0.839	1.017	-0.003	1.236	-0.013	0.259	-0.102	0.417
Quick meals	0.001	0.820	-0.154	1.371	-0.233	0.512	0.017	0.548
Sugary drinks	0.327	0.656	-0.011	1.424	0.102	0.468	0.235	0.477
Non-sugary drinks	-0.121	1.043	-0.092	1.414	-0.195	0.389	-0.216	0.493
Sweet snacks	-0.409	1.008	0.219	1.368	-0.046	0.527	-0.092	0.552
Hot beverages	-1.063	0.823	0.313	1.364	0.026	0.350	0.198	0.499
Others	-0.477	1.290	-1.141	1.627	-1.113	0.521	-1.067	0.424

(SE=bootstrapped standard errors)