

Supplement to “Income effects and the welfare consequences of tax in differentiated product oligopoly”

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APPENDIX A: COEFFICIENTS ESTIMATES FOR ALTERNATIVE SPECIFICATIONS

In Section 4.7 of the paper (Table 3), we report the coefficient estimates for the cubic utility specification. Here we report the coefficient estimates of the multinomial logit and linear utility specifications (Table A.1), of the log utility specifications (Table A.2), and of the preference shifter specifications (Table A.3). The quadratic preference shifter specification corresponds to a linearization of the cubic utility specification.

APPENDIX B: ELASTICITIES AND COSTS

Here we include estimated market price elasticities and marginal costs for the cubic utility, linear utility, and preference shifter specifications. Table B.1 presents a matrix of average market own-price and cross-price elasticities for the 10 products with the highest market share. It contains the matrix for each of the three model specifications. The numbers show (i) demand for all products is elastic, with own-price elasticities ranging from -4.3 to -1.5 ; (ii) cross-price elasticities exhibit a high degree of variation, showing estimates are far from those for a conditional logit (in which there would be no within column variation in cross-price elasticities) (the cross-price elasticities also indicate a much higher degree of substitution within the butter products (Ar: Anchor NZ 500 g, Ar: Lurpak spread ss 500 g, and Ar: Lurpak light ss 500 g) than between them and the margarine products); (iii) the three models yield similar estimates for market own-price and cross-price elasticities. This contrasts with the model predictions for household level elasticities, which differ (see Table 4 and Figure 6 of the paper).

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TABLE A.1. Coefficient estimates: linear utility.

	No Heterogeneity		With Heterogeneity	
	Coefficient Estimate	Standard Error	Coefficient Estimate	Standard Error
Random Coefficients (with heterogeneity only)				
<i>Mean terms</i>				
$(y - p)$	14.5344	0.5946	21.1194	0.6959
<i>Interaction terms</i>				
$(y - p) * hh2$			-0.1532	0.4070
$(y - p) * hh3$			1.2451	0.4877
$(y - p) * hh4$			4.1448	0.5346
$(y - p) * hh5$			8.1510	0.6740
<i>Variance-covariance terms</i>				
Var($y - p$)			74.7259	1.5286
Var(Butter)			13.7058	0.4626
Cov($y - p$, Butter)			1.7816	0.0328
Fixed Coefficients				
Promotion	0.2538	0.0262	0.1915	0.0271
Advertising	0.0042	0.0049	0.0081	0.0051
Advertising ²	-0.0001	0.0001	-0.0002	0.0001
500 g	2.4303	0.0814	2.3903	0.0832
1 kg	3.1641	0.1340	2.3044	0.1455
500 g * Household size			0.2008	0.0166
1 kg * Household size			0.5761	0.0289
No purchase * Mixed work			-0.2500	0.0482
No purchase * Non full time			-0.2725	0.0311
No purchase * Retired			-0.4775	0.0328
No purchase * hh2			-0.4750	0.0514
No purchase * hh3			-0.6121	0.0622
No purchase * hh4			-0.8279	0.0668
No purchase * hh5			-1.0746	0.0860
Brand fixed effects	Yes		Yes	

Note: Sample size is 10,012 households with five observations per household. Random coefficients are assumed to be distributed joint normally. The butter dummy is collinear with the brand effects and therefore has a mean coefficient that is constrained to be zero.

Table B.2 presents the mean marginal cost estimates for the 10 largest market share products. They are based on the assumption that firms compete in a Nash-Bertrand game, and, therefore, are a functions of the market level price elasticities and the ownership structure of products. Given the similarities in market elasticities between the three model specifications, it is not surprising that the models generate a similar set of marginal costs. Margins are estimated to be lower for the butter products than for the margarine products.

TABLE A.2. Coefficient estimates: log utility.

	Log-Linear Utility		Log-Cubic Utility	
	Coefficient Estimate	Standard Error	Coefficient Estimate	Standard Error
Random coefficients				
<i>Mean terms</i>				
$\ln(y - p)$	36.0098	1.3062	220.0412	60.7684
$\ln(y - p)^2$			-61.2514	18.7490
$\ln(y - p)^3$			7.4094	1.9260
<i>Interaction terms</i>				
$\ln(y - p) * hh2$	5.0112	1.2420	14.3735	74.8393
$\ln(y - p)^2 * hh2$			-2.5404	22.4407
$\ln(y - p)^3 * hh2$			0.2404	2.2380
$\ln(y - p) * hh3$	13.3274	1.6709	-111.8476	102.3358
$\ln(y - p)^2 * hh3$			33.0628	29.2289
$\ln(y - p)^3 * hh3$			-2.8514	2.7884
$\ln(y - p) * hh4$	27.2697	1.9020	10.9113	108.3736
$\ln(y - p)^2 * hh4$			-4.1598	30.5735
$\ln(y - p)^3 * hh4$			1.2143	2.8865
$\ln(y - p) * hh5$	49.1824	2.6604	221.7783	165.3609
$\ln(y - p)^2 * hh5$			-63.1248	45.4423
$\ln(y - p)^3 * hh5$			7.1645	4.1613
<i>Variance-covariance terms</i>				
$\text{Var}(\ln(y - p))$	24.9635	0.5111	25.7433	0.5108
$\text{Var}(\text{Butter})$	1.1398	0.0490	1.2390	0.0486
$\text{Cov}(\ln(y - p), \text{Butter})$	1.7374	0.0328	-1.7108	0.0335
Fixed coefficients				
Promotion	0.4252	0.0236	0.2116	0.0270
Advertising	-0.0016	0.0051	0.0070	0.0051
Advertising ²	-0.0000	0.0001	-0.0002	0.0001
500 g	1.3896	0.0602	2.2444	0.0822
1 kg	0.3932	0.0980	2.0057	0.1438
500 g * Household size	0.1596	0.0153	0.1973	0.0161
1 kg * Household size	0.5158	0.0262	0.6079	0.0283
No purchase * Mixed work	-0.2038	0.0448	-0.2126	0.0452
No purchase * Non full time	-0.2670	0.0294	-0.2666	0.0297
No purchase * Retired	-0.4315	0.0318	-0.4374	0.0320
No purchase * hh2	-0.2572	0.0494	-0.2815	0.0514
No purchase * hh3	-0.3447	0.0602	-0.3796	0.0619
No purchase * hh4	-0.4723	0.0647	-0.5928	0.0664
No purchase * hh5	-0.6863	0.0825	-0.8563	0.0842
Brand fixed effects		Yes		Yes

Note: Sample size is 10,012 households with five observations per household. Random coefficients are assumed to be distributed joint normally. The butter dummy is collinear with the brand effects and therefore has a mean coefficient that is constrained to be zero.

TABLE A.3. Coefficient estimates: preference shifter.

	Linear Shifter		Quadratic Shifter	
	Coefficient Estimate	Standard Error	Coefficient Estimate	Standard Error
Random coefficients				
<i>Mean terms</i>				
p	2.6819	0.1019	3.0863	0.1932
<i>Interaction terms</i>				
$p * y$	-0.1981	0.0239	-0.4496	0.1041
$p * y^2$			0.0336	0.0142
$p * hh2$	0.0858	0.0966	0.5802	0.2272
$p * y * hh2$	0.0424	0.0262	-0.1306	0.1201
$p * y^2 * hh2$			0.0124	0.0156
$p * hh3$	0.4437	0.1197	0.4613	0.3001
$p * y * hh3$	0.0207	0.0285	0.0871	0.1411
$p * y^2 * hh3$			-0.0151	0.0169
$p * hh4$	0.7514	0.1297	0.9817	0.3345
$p * y * hh4$	0.0296	0.0291	0.0188	0.1501
$p * y^2 * hh4$			-0.0088	0.0174
$p * hh5$	1.3818	0.1729	2.5394	0.4689
$p * y * hh5$	0.0013	0.0342	-0.3818	0.1962
$p * y^2 * hh5$			0.0255	0.0210
<i>Variance-covariance terms</i>				
Var(p)	0.7256	0.0151	0.7199	0.0150
Var(Butter)	1.4465	0.0470	1.4607	0.0475
Cov(p , Butter)	1.6856	0.0335	1.6738	0.0337
Fixed coefficients				
Promotion	0.1906	0.0271	0.1907	0.0271
Advertising	0.0081	0.0051	0.0081	0.0052
Advertising ²	-0.0002	0.0001	-0.0002	0.0001
500 g	2.3936	0.0833	2.3934	0.0834
1 kg	2.3062	0.1457	2.3047	0.1459
500 g * Household size	0.2000	0.0167	0.2009	0.0167
1 kg * Household size	0.5768	0.0292	0.5776	0.0292
No purchase * Mixed work	-0.2197	0.0482	-0.2159	0.0482
No purchase * Non full time	-0.2745	0.0309	-0.2698	0.0309
No purchase * Retired	-0.4562	0.0324	-0.4449	0.0324
No purchase * hh2	-0.4707	0.0514	-0.4753	0.0515
No purchase * hh3	-0.6195	0.0624	-0.6147	0.0625
No purchase * hh4	-0.8255	0.0670	-0.8215	0.0670
No purchase * hh5	-1.0907	0.0861	-1.0925	0.0862
Brand fixed effects		Yes		Yes

Note: Sample size is 10,012 households with five observations per household. Random coefficients are assumed to be distributed joint normally. The butter dummy is collinear with the brand effects and therefore has a mean coefficient that is constrained to be zero.

TABLE B.1. Own-price and cross-price elasticities.

	Polynomial Utility										
	Ar: Anchor NZ 500 g	Ar: Lurpak Spread ss 500 g	Ar: Lurpak light ss 500 g	DC: Clover Spread 500 g	DC: Utterly Butterly 500 g	Un: Flora Buttery 500 g	Un: Flora Light 500 g	Un: ICBINB 500 g	Un: ICBINB Light 500 g	Un: Stork 500 g	Outside Option
Ar: Anchor NZ 500 g	-4.1981	0.1232	0.1204	0.0289	0.0313	0.0299	0.0295	0.0316	0.0310	0.0321	0.0324
Ar: Lurpak spread ss 500 g	0.2103	-4.3425	0.2156	0.0489	0.0523	0.0526	0.0498	0.0530	0.0531	0.0537	0.0539
Ar: Lurpak light ss 500 g	0.1480	0.1554	-4.4219	0.0349	0.0377	0.0380	0.0361	0.0383	0.0385	0.0386	0.0387
DC: Clover spread 500 g	0.0290	0.0290	0.0289	-2.0684	0.0443	0.0446	0.0444	0.0422	0.0418	0.0441	0.0347
DC: Utterly Butterly 500 g	0.0206	0.0200	0.0200	0.0290	-1.5514	0.0292	0.0288	0.0302	0.0299	0.0308	0.0254
Un: Flora buttery 500 g	0.0349	0.0361	0.0362	0.0520	0.0524	-1.8528	0.0514	0.0538	0.0544	0.0536	0.0431
Un: Flora light 500 g	0.0233	0.0233	0.0234	0.0349	0.0351	0.0349	-2.1155	0.0359	0.0358	0.0351	0.0269
Un: ICBINB 500 g	0.0286	0.0283	0.0283	0.0392	0.0433	0.0419	0.0411	-1.6170	0.0450	0.0436	0.0354
Un: ICBINB light 500 g	0.0139	0.0141	0.0141	0.0192	0.0213	0.0211	0.0203	0.0223	-1.6661	0.0215	0.0175
Un: Stork 500 g	0.0111	0.0110	0.0110	0.0152	0.0166	0.0159	0.0153	0.0165	0.0165	-1.4524	0.0142

(Continues)

TABLE B.1. *Continued.*

	Linear Utility										
	Ar: Anchor NZ 500 g	Ar: Lurpak Spread ss 500 g	Ar: Lurpak Light ss 500 g	DC: Clover Spread 500 g	DC: Utterly Butterly 500 g	Un: Flora Buttery 500 g	Un: Flora Light 500 g	Un: ICBINB 500 g	Un: ICBINB Light 500 g	Un: Stork 500 g	Outside Option
Ar: Anchor NZ 500 g	-4.1794	0.1237	0.1212	0.0289	0.0314	0.0301	0.0296	0.0318	0.0314	0.0322	0.0328
Ar: Lurpak spread ss 500 g	0.2136	-4.2821	0.2208	0.0495	0.0529	0.0534	0.0505	0.0539	0.0542	0.0544	0.0547
Ar: Lurpak light ss 500 g	0.1509	0.1595	-4.3569	0.0355	0.0382	0.0387	0.0367	0.0390	0.0393	0.0392	0.0393
DC: Clover spread 500 g	0.0285	0.0286	0.0285	-2.0793	0.0444	0.0447	0.0445	0.0423	0.0420	0.0442	0.0350
DC: Utterly Butterly 500 g	0.0203	0.0197	0.0197	0.0291	-1.5609	0.0293	0.0289	0.0303	0.0300	0.0309	0.0257
Un: Flora buttery 500 g	0.0346	0.0357	0.0359	0.0522	0.0525	-1.8564	0.0517	0.0540	0.0546	0.0537	0.0434
Un: Flora light 500 g	0.0230	0.0229	0.0231	0.0350	0.0351	0.0350	-2.1270	0.0360	0.0359	0.0351	0.0272
Un: ICBINB 500 g	0.0284	0.0280	0.0280	0.0395	0.0434	0.0421	0.0414	-1.6216	0.0452	0.0437	0.0356
Un: ICBINB light 500 g	0.0139	0.0140	0.0140	0.0194	0.0213	0.0212	0.0204	0.0224	-1.6682	0.0216	0.0175
Un: Stork 500 g	0.0110	0.0109	0.0109	0.0153	0.0166	0.0160	0.0154	0.0166	0.0166	-1.4585	0.0143

(Continues)

TABLE B.1. *Continued.*

	Preference Shifter										
	Ar: Anchor NZ 500 g	Ar: Lurpak Spread ss 500 g	Ar: Lurpak Light ss 500 g	DC: Clover Spread 500 g	DC: Utterly Butterly 500 g	Un: Flora Buttery 500 g	Un: Flora Light 500 g	Un: ICBINB 500 g	Un: ICBINB Light 500 g	Un: Stork 500 g	Outside Option
Ar: Anchor NZ 500 g	-4.1873	0.1226	0.1199	0.0288	0.0312	0.0298	0.0295	0.0315	0.0310	0.0319	0.0323
Ar: Lurpak spread ss 500 g	0.2098	-4.3107	0.2160	0.0488	0.0522	0.0524	0.0498	0.0529	0.0531	0.0535	0.0537
Ar: Lurpak light ss 500 g	0.1479	0.1558	-4.3865	0.0349	0.0376	0.0379	0.0361	0.0383	0.0385	0.0385	0.0385
DC: Clover spread 500 g	0.0290	0.0291	0.0290	-2.0836	0.0445	0.0449	0.0447	0.0424	0.0421	0.0443	0.0349
DC: Utterly Butterly 500 g	0.0207	0.0201	0.0201	0.0293	-1.5673	0.0294	0.0290	0.0305	0.0302	0.0311	0.0257
Un: Flora buttery 500 g	0.0351	0.0362	0.0363	0.0524	0.0528	-1.8690	0.0518	0.0542	0.0548	0.0540	0.0435
Un: Flora light 500 g	0.0234	0.0233	0.0235	0.0351	0.0352	0.0351	-2.1301	0.0361	0.0360	0.0352	0.0271
Un: ICBINB 500 g	0.0288	0.0284	0.0284	0.0396	0.0437	0.0423	0.0415	-1.6326	0.0455	0.0440	0.0358
Un: ICBINB light 500 g	0.0140	0.0141	0.0142	0.0194	0.0215	0.0213	0.0205	0.0225	-1.6813	0.0217	0.0176
Un: Stork 500 g	0.0111	0.0110	0.0110	0.0154	0.0168	0.0161	0.0154	0.0167	0.0167	-1.4684	0.0144

Note: Each cell contains the price elasticity of demand for the product indicated in the first row 1 with respect to the price of the product in the second column. Numbers are means across markets.

TABLE B.2. Marginal costs: top 10 market share products.

	Price	Polynomial Utility		Linear Utility		Preference Shifter	
		Cost	Margin	Cost	Margin	Cost	Margin
Ar: Anchor NZ 500 g	1.99	1.42	0.29	1.42	0.29	1.42	0.29
Ar: Lurpak spread ss 500 g	2.15	1.57	0.27	1.56	0.27	1.57	0.27
Ar: Lurpak light ss 500 g	2.17	1.59	0.27	1.58	0.27	1.58	0.27
DC: Clover spread 500 g	1.19	0.58	0.52	0.58	0.51	0.58	0.51
DC: Utterly Butterly 500 g	0.81	0.25	0.69	0.26	0.68	0.26	0.68
Un: Flora buttery 500 g	1.02	0.37	0.64	0.37	0.64	0.37	0.63
Un: Flora light 500 g	1.22	0.53	0.57	0.53	0.56	0.53	0.56
Un: ICBINB 500 g	0.85	0.23	0.73	0.23	0.73	0.23	0.73
Un: ICBINB light 500 g	0.87	0.24	0.72	0.24	0.72	0.25	0.71
Un: Stork 500 g	0.73	0.13	0.83	0.13	0.82	0.13	0.82

Note: Margins are defined as $(p - mc)/p$. Numbers are market share weighted means.

APPENDIX C: ELASTICITIES AND COSTS

In Section 4.8.1 of the paper, we use the specific tax to compare predictions from different model specifications about tax pass-through and household level compensating variations. Here we show that similar conclusions hold for the ad valorem tax. Figure C.1 shows the patterns of pass-through across products for each model specification (the ad valorem tax analog of Figure 7). In contrast to the specific tax, the ad valorem tax is undershifted to final prices: average pass-through under the cubic utility model is 54%. However, as with the specific tax, the cubic utility, linear utility, and preference shifter models generate the same pattern of pass-through across products and the multinomial logit model generates pass-through that, on average, is lower (33% on average).

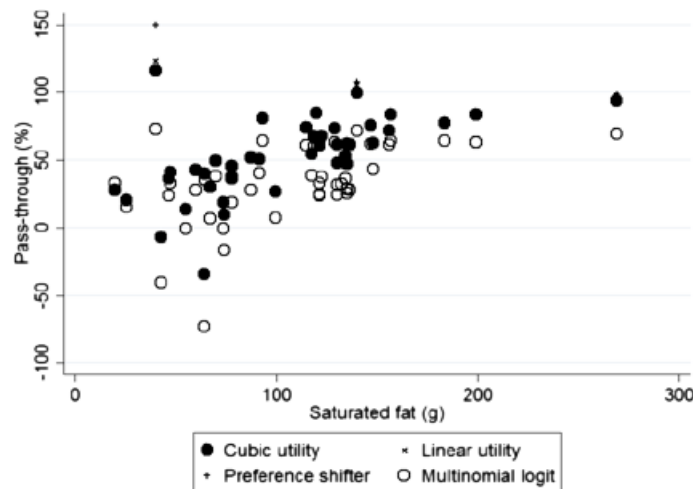


FIGURE C.1. Pass-through of ad valorem tax across products. Notes: For each product in each market we compute the pass-through of the ad valorem tax. The figure is a scatter plot of products' mean pass-through across markets with their saturated fat contents.

TABLE C.1. Compensating variation from ad valorem tax for household size 2.

Specification	Mean Compensating Variation	Average Deviation From Mean Compensating Variation for Quartile of Grocery Expenditure Distribution			
		1	2	3	4
Cubic utility	1.53 [1.47, 1.63]	-0.53 [-0.60, -0.47]	-0.07 [-0.14, -0.05]	0.20 [0.16, 0.26]	0.40 [0.32, 0.51]
Linear utility	1.48 [1.45, 1.59]	-0.03 [-0.03, -0.03]	0.00 [0.00, 0.00]	0.03 [0.03, 0.03]	0.00 [-0.01, 0.00]
Preference shifter	1.59 [1.49, 1.67]	-0.45 [-0.50, -0.38]	-0.17 [-0.23, -0.14]	0.05 [0.04, 0.09]	0.57 [0.45, 0.69]

Note: Numbers are for households with two members. Numbers give the compensating variation for the average household associated with the simulated ad valorem tax. We measure expenditure as the households' mean weekly grocery expenditure over the year. Numbers are for a calendar year. The 95% confidence intervals are shown in brackets.

Table C.1 describes compensating variation from the ad valorem tax (the ad valorem tax analog of Table 5). As the ad valorem tax is undershifted to consumer prices, compensating variation from the tax is less than for the specific tax. In common with the specific tax, the preference shifter and linear utility models fail to fully replicate how compensating variation varies across the grocery expenditure distribution under the cubic utility specification.

Co-editor Rosa L. Matzkin handled this manuscript.

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