

# IO Problem Set 1 (BLP)

November 3, 2021

## **Problem 1**

**Estimate the Model using OLS, with price and promotion as characteristics**

<b>Dep. Variable:</b>	Y	<b>R-squared:</b>	0.158
<b>Model:</b>	OLS	<b>Adj. R-squared:</b>	0.158
<b>Method:</b>	Least Squares	<b>F-statistic:</b>	3610.
<b>Date:</b>	Thu, 04 Nov 2021	<b>Prob (F-statistic):</b>	0.00
<b>Time:</b>	05:19:39	<b>Log-Likelihood:</b>	-56307.
<b>No. Observations:</b>	38544	<b>AIC:</b>	1.126e+05
<b>Df Residuals:</b>	38541	<b>BIC:</b>	1.126e+05
<b>Df Model:</b>	2		
<b>Covariance Type:</b>	nonrobust		

  

	<b>coef</b>	<b>std err</b>	<b>t</b>	<b>P&gt;  t </b>	<b>[0.025</b>	<b>0.975]</b>
<b>Intercept</b>	-7.6267	0.014	-532.839	0.000	-7.655	-7.599
<b>prices</b>	-0.2496	0.003	-84.768	0.000	-0.255	-0.244
<b>prom_</b>	-0.0311	0.019	-1.653	0.098	-0.068	0.006

  

<b>Omnibus:</b>	1648.591	<b>Durbin-Watson:</b>	0.434
<b>Prob(Omnibus):</b>	0.000	<b>Jarque-Bera (JB):</b>	1461.418
<b>Skew:</b>	-0.415	<b>Prob(JB):</b>	0.00
<b>Kurtosis:</b>	2.529	<b>Cond. No.</b>	17.7

Notes:

[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

Estimate the Model using OLS, with price and promotion as characteristics, and brand dummies

<b>Dep. Variable:</b>	Y	<b>R-squared:</b>	0.654
<b>Model:</b>	OLS	<b>Adj. R-squared:</b>	0.654
<b>Method:</b>	Least Squares	<b>F-statistic:</b>	6081.
<b>Date:</b>	Thu, 04 Nov 2021	<b>Prob (F-statistic):</b>	0.00
<b>Time:</b>	05:20:51	<b>Log-Likelihood:</b>	-39138.
<b>No. Observations:</b>	38544	<b>AIC:</b>	7.830e+04
<b>Df Residuals:</b>	38531	<b>BIC:</b>	7.841e+04
<b>Df Model:</b>	12		
<b>Covariance Type:</b>	nonrobust		

  

	coef	std err	t	P >  t	[0.025	0.975]
Intercept	-6.0745	0.036	-167.065	0.000	-6.146	-6.003
C(brand)[T.2]	-0.0048	0.022	-0.218	0.828	-0.048	0.039
C(brand)[T.3]	-0.4578	0.040	-11.502	0.000	-0.536	-0.380
C(brand)[T.4]	-0.4303	0.017	-25.951	0.000	-0.463	-0.398
C(brand)[T.5]	-0.8868	0.024	-37.403	0.000	-0.933	-0.840
C(brand)[T.6]	-1.3850	0.051	-27.408	0.000	-1.484	-1.286
C(brand)[T.7]	-1.6527	0.018	-94.139	0.000	-1.687	-1.618
C(brand)[T.8]	-2.2856	0.016	-141.034	0.000	-2.317	-2.254
C(brand)[T.9]	-1.9340	0.017	-111.950	0.000	-1.968	-1.900
C(brand)[T.10]	-1.8983	0.022	-87.306	0.000	-1.941	-1.856
C(brand)[T.11]	-2.1754	0.019	-113.355	0.000	-2.213	-2.138
prices	-0.3412	0.010	-33.864	0.000	-0.361	-0.321
prom_	0.3294	0.013	26.122	0.000	0.305	0.354

  

<b>Omnibus:</b>	2773.498	<b>Durbin-Watson:</b>	1.024
<b>Prob(Omnibus):</b>	0.000	<b>Jarque-Bera (JB):</b>	3867.305
<b>Skew:</b>	-0.618	<b>Prob(JB):</b>	0.00
<b>Kurtosis:</b>	3.938	<b>Cond. No.</b>	112.

Notes:

[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

<b>Dep. Variable:</b>	Y	<b>R-squared:</b>	0.722
<b>Model:</b>	OLS	<b>Adj. R-squared:</b>	0.716
<b>Method:</b>	Least Squares	<b>F-statistic:</b>	121.9
<b>Date:</b>	Thu, 04 Nov 2021	<b>Prob (F-statistic):</b>	0.00
<b>Time:</b>	05:21:32	<b>Log-Likelihood:</b>	-34946.
<b>No. Observations:</b>	38544	<b>AIC:</b>	7.150e+04
<b>Df Residuals:</b>	37739	<b>BIC:</b>	7.839e+04
<b>Df Model:</b>	804		
<b>Covariance Type:</b>	nonrobust		

  

	coef	std err	t	P>  t	[0.025	0.975]
<b>Intercept</b>	-6.1994	0.093	-66.365	0.000	-6.382	-6.016
<b>prices</b>	-0.3302	0.010	-34.349	0.000	-0.349	-0.311
<b>prom_</b>	0.3288	0.011	28.619	0.000	0.306	0.351

  

<b>Omnibus:</b>	4044.934	<b>Durbin-Watson:</b>	1.268
<b>Prob(Omnibus):</b>	0.000	<b>Jarque-Bera (JB):</b>	7222.052
<b>Skew:</b>	-0.721	<b>Prob(JB):</b>	0.00
<b>Kurtosis:</b>	4.555	<b>Cond. No.</b>	4.08e+03

Notes:

- [1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
- [2] The condition number is large, 4.08e+03. This might indicate that there are strong multicollinearity or other numerical problems. Dummies omitted.

**Estimate the Model using OLS, with price and promotion as characteristics, and store-brand dummies**

<b>Dep. Variable:</b>	Y	<b>R-squared:</b>	0.1531
<b>Estimator:</b>	IV-2SLS	<b>Adj. R-squared:</b>	0.1531
<b>No. Observations:</b>	38544	<b>F-statistic:</b>	5255.4
<b>Date:</b>	Thu, Nov 04 2021	<b>P-value (F-stat)</b>	0.0000
<b>Time:</b>	05:25:20	<b>Distribution:</b>	chi2(2)
<b>Cov. Estimator:</b>	robust		

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
<b>Intercept</b>	-7.8181	0.0150	-520.30	0.0000	-7.8476	-7.7887
<b>prom_</b>	-0.0068	0.0170	-0.4034	0.6866	-0.0401	0.0264
<b>prices</b>	-0.2066	0.0029	-71.884	0.0000	-0.2122	-0.2009

Endogenous: prices  
Instruments: cost\_  
Robust Covariance (Heteroskedastic)  
Debiased: False

Estimate the models from parts 1–3 using wholesale cost as an instrument

<b>Dep. Variable:</b>	Y	<b>R-squared:</b>	0.6446
<b>Estimator:</b>	IV-2SLS	<b>Adj. R-squared:</b>	0.6445
<b>No. Observations:</b>	38544	<b>F-statistic:</b>	9.69e+04
<b>Date:</b>	Thu, Nov 04 2021	<b>P-value (F-stat)</b>	0.0000
<b>Time:</b>	05:26:08	<b>Distribution:</b>	chi2(12)
<b>Cov. Estimator:</b>	robust		

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
<b>Intercept</b>	-7.2171	0.0652	-110.69	0.0000	-7.3449	-7.0893
<b>C(brand)[T.2]</b>	-0.5161	0.0309	-16.703	0.0000	-0.5766	-0.4555
<b>C(brand)[T.3]</b>	-1.6627	0.0698	-23.833	0.0000	-1.7994	-1.5260
<b>C(brand)[T.4]</b>	-0.2833	0.0147	-19.314	0.0000	-0.3121	-0.2546
<b>C(brand)[T.5]</b>	-1.4660	0.0358	-40.904	0.0000	-1.5363	-1.3958
<b>C(brand)[T.6]</b>	-2.9699	0.0914	-32.484	0.0000	-3.1491	-2.7907
<b>C(brand)[T.7]</b>	-1.4158	0.0181	-78.185	0.0000	-1.4513	-1.3803
<b>C(brand)[T.8]</b>	-2.3613	0.0137	-172.35	0.0000	-2.3882	-2.3344
<b>C(brand)[T.9]</b>	-2.1365	0.0169	-126.55	0.0000	-2.1696	-2.1034
<b>C(brand)[T.10]</b>	-1.4120	0.0321	-44.036	0.0000	-1.4749	-1.3492
<b>C(brand)[T.11]</b>	-2.5260	0.0283	-89.396	0.0000	-2.5814	-2.4707
<b>prom_</b>	0.4307	0.0145	29.801	0.0000	0.4024	0.4590
<b>prices</b>	-0.0081	0.0189	-0.4287	0.6682	-0.0452	0.0290

Endogenous: prices  
Instruments: cost\_  
Robust Covariance (Heteroskedastic)  
Debiased: False

Estimate the models from parts 1–3 using the Hausman instrument

<b>Dep. Variable:</b>	Y	<b>R-squared:</b>	0.7150
<b>Estimator:</b>	IV-2SLS	<b>Adj. R-squared:</b>	0.7090
<b>No. Observations:</b>	38544	<b>F-statistic:</b>	1.766e+05
<b>Date:</b>	Thu, Nov 04 2021	<b>P-value (F-stat)</b>	0.0000
<b>Time:</b>	05:27:37	<b>Distribution:</b>	chi2(804)
<b>Cov. Estimator:</b>	robust		

  

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
<b>Intercept</b>	-7.2138	0.0775	-93.106	0.0000	-7.3657	-7.0620
<b>prom_</b>	0.4193	0.0132	31.774	0.0000	0.3934	0.4451
<b>prices</b>	-0.0346	0.0178	-1.9442	0.0519	-0.0695	0.0003

Table 1: IV-2SLS Estimation Summary, dummies suppressed

Endogenous: prices  
Instruments: cost\_  
Robust Covariance (Heteroskedastic)  
Debiased: False

<b>Dep. Variable:</b>	Y	<b>R-squared:</b>	0.1578
<b>Estimator:</b>	IV-2SLS	<b>Adj. R-squared:</b>	0.1577
<b>No. Observations:</b>	38544	<b>F-statistic:</b>	9465.0
<b>Date:</b>	Thu, Nov 04 2021	<b>P-value (F-stat)</b>	0.0000
<b>Time:</b>	05:40:33	<b>Distribution:</b>	chi2(2)
<b>Cov. Estimator:</b>	robust		

  

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
<b>Intercept</b>	-7.6143	0.0135	-565.64	0.0000	-7.6407	-7.5879
<b>prom_</b>	-0.0327	0.0170	-1.9257	0.0541	-0.0660	0.0006
<b>prices</b>	-0.2524	0.0026	-97.062	0.0000	-0.2574	-0.2473

Endogenous: prices  
Instruments: pricestore1, pricestore2, pricestore3, pricestore4, pricestore5, pricestore6, pricestore7, pricestore8, pricestore9, pricestore10, pricestore11, pricestore12, pricestore13, pricestore14, pricestore15, pricestore16, pricestore17, pricestore18, pricestore19, pricestore20, pricestore21, pricestore22, pricestore23, pricestore24, pricestore25, pricestore26, pricestore27, pricestore28, pricestore29, pricestore30  
Robust Covariance (Heteroskedastic)  
Debiased: False

<b>Dep. Variable:</b>	Y	<b>R-squared:</b>	0.6511
<b>Estimator:</b>	IV-2SLS	<b>Adj. R-squared:</b>	0.6510
<b>No. Observations:</b>	38544	<b>F-statistic:</b>	9.529e+04
<b>Date:</b>	Thu, Nov 04 2021	<b>P-value (F-stat)</b>	0.0000
<b>Time:</b>	05:41:01	<b>Distribution:</b>	chi2(12)
<b>Cov. Estimator:</b>	robust		

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
<b>Intercept</b>	-5.4061	0.0539	-100.33	0.0000	-5.5117	-5.3005
<b>C(product_ids)[T.2]</b>	0.2942	0.0259	11.370	0.0000	0.2435	0.3449
<b>C(product_ids)[T.3]</b>	0.2471	0.0574	4.3071	0.0000	0.1347	0.3595
<b>C(product_ids)[T.4]</b>	-0.5162	0.0140	-36.812	0.0000	-0.5437	-0.4888
<b>C(product_ids)[T.5]</b>	-0.5479	0.0298	-18.367	0.0000	-0.6064	-0.4894
<b>C(product_ids)[T.6]</b>	-0.4578	0.0751	-6.0967	0.0000	-0.6050	-0.3107
<b>C(product_ids)[T.7]</b>	-1.7913	0.0169	-105.81	0.0000	-1.8245	-1.7581
<b>C(product_ids)[T.8]</b>	-2.2413	0.0143	-156.43	0.0000	-2.2694	-2.2132
<b>C(product_ids)[T.9]</b>	-1.8155	0.0156	-116.73	0.0000	-1.8460	-1.7850
<b>C(product_ids)[T.10]</b>	-2.1827	0.0280	-77.963	0.0000	-2.2376	-2.1279
<b>C(product_ids)[T.11]</b>	-1.9703	0.0231	-85.436	0.0000	-2.0155	-1.9251
<b>prom_</b>	0.2701	0.0143	18.947	0.0000	0.2421	0.2980
<b>prices</b>	-0.5361	0.0155	-34.507	0.0000	-0.5665	-0.5056

Endogenous: prices

Instruments: pricestore1, pricestore2, pricestore3, pricestore4, pricestore5, pricestore6, pricestore7, pricestore8, pricestore9, pricestore10, pricestore11, pricestore12, pricestore13, pricestore14, pricestore15, pricestore16, pricestore17, pricestore18, pricestore19, pricestore20, pricestore21, pricestore22, pricestore23, pricestore24, pricestore25, pricestore26, pricestore27, pricestore28, pricestore29, pricestore30

Robust Covariance (Heteroskedastic)

Debiased: False

### Mean own-price elasticities from the estimates in models 1–3

These results make sense. As a rule of thumb, the own-price elasticities should be  $\in (-2, -5)$ . The IV estimates using the Hausman instrument are approximately in this range. The OLS estimates are not, indicating that endogeneity is a practical concern in this setting. The estimates with wholesale cost as an instrument are also “too small”, indicating that wholesale cost may not be a viable instrument in this context.



<b>Dep. Variable:</b>	Y	<b>R-squared:</b>	0.7183
<b>Estimator:</b>	IV-2SLS	<b>Adj. R-squared:</b>	0.7123
<b>No. Observations:</b>	38544	<b>F-statistic:</b>	1.711e+05
<b>Date:</b>	Thu, Nov 04 2021	<b>P-value (F-stat)</b>	0.0000
<b>Time:</b>	05:42:30	<b>Distribution:</b>	chi2(804)
<b>Cov. Estimator:</b>	robust		

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
<b>Intercept</b>	-5.4606	0.0662	-82.482	0.0000	-5.5903	-5.3308
<b>prom_</b>	0.2630	0.0130	20.297	0.0000	0.2376	0.2884
<b>prices</b>	-0.5454	0.0138	-39.560	0.0000	-0.5725	-0.5184

Endogenous: prices

Instruments: pricestore1, pricestore2, pricestore3, pricestore4, pricestore5, pricestore6, pricestore7, pricestore8, pricestore9, pricestore10, pricestore11, pricestore12, pricestore13, pricestore14, pricestore15, pricestore16, pricestore17, pricestore18, pricestore19, pricestore20, pricestore21, pricestore22, pricestore23, pricestore24, pricestore25, pricestore26, pricestore27, pricestore28, pricestore29, pricestore30

Robust Covariance (Heteroskedastic) Dummies omitted.

Debiased: False

	OLS1	OLS2	OLS3	IV4.1	IV4.2	IV4.3	IV5.1	IV5.2	IV5.3
brand									
1	-0.852929	-1.166183	-1.128481	-0.706043	-0.027733	-0.118239	-0.862496	-1.832176	-1.864240
2	-1.232714	-1.685451	-1.630960	-1.020423	-0.040082	-0.170887	-1.246541	-2.647991	-2.694332
3	-1.750607	-2.393550	-2.316167	-1.449128	-0.056921	-0.242681	-1.770243	-3.760477	-3.826287
4	-0.739114	-1.010568	-0.977896	-0.611828	-0.024032	-0.102461	-0.747405	-1.587691	-1.615476
5	-1.283685	-1.755141	-1.698398	-1.062616	-0.041739	-0.177953	-1.298083	-2.757481	-2.805738
6	-2.036190	-2.784018	-2.694011	-1.685529	-0.066207	-0.282271	-2.059029	-4.373936	-4.450483
7	-0.666923	-0.911862	-0.882382	-0.552069	-0.021685	-0.092453	-0.674403	-1.432616	-1.457688
8	-0.900107	-1.230688	-1.190900	-0.745096	-0.029267	-0.124779	-0.910203	-1.933518	-1.967356
9	-0.989782	-1.353297	-1.309545	-0.819327	-0.032183	-0.137210	-1.000884	-2.126149	-2.163357
10	-0.481135	-0.657841	-0.636573	-0.398277	-0.015644	-0.066698	-0.486532	-1.033526	-1.051613
11	-1.109697	-1.517254	-1.468201	-0.918591	-0.036082	-0.153834	-1.122144	-2.383739	-2.425456