Technical Appendix

Econ HW 2

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5/1/2019

1. Aggregate Demand, Supply, and Surplus

A linear regression on the data returned the intercept and slope for both the high and low demand groups

High income demand curve:
$Price = 23.3914418 - (1.2966378 \times 10^{-4})Q$

Low income demand curve:
$Price = 21.9908534 - (1.3551741 \times 10^{-4})Q$

a. Find aggregate demand

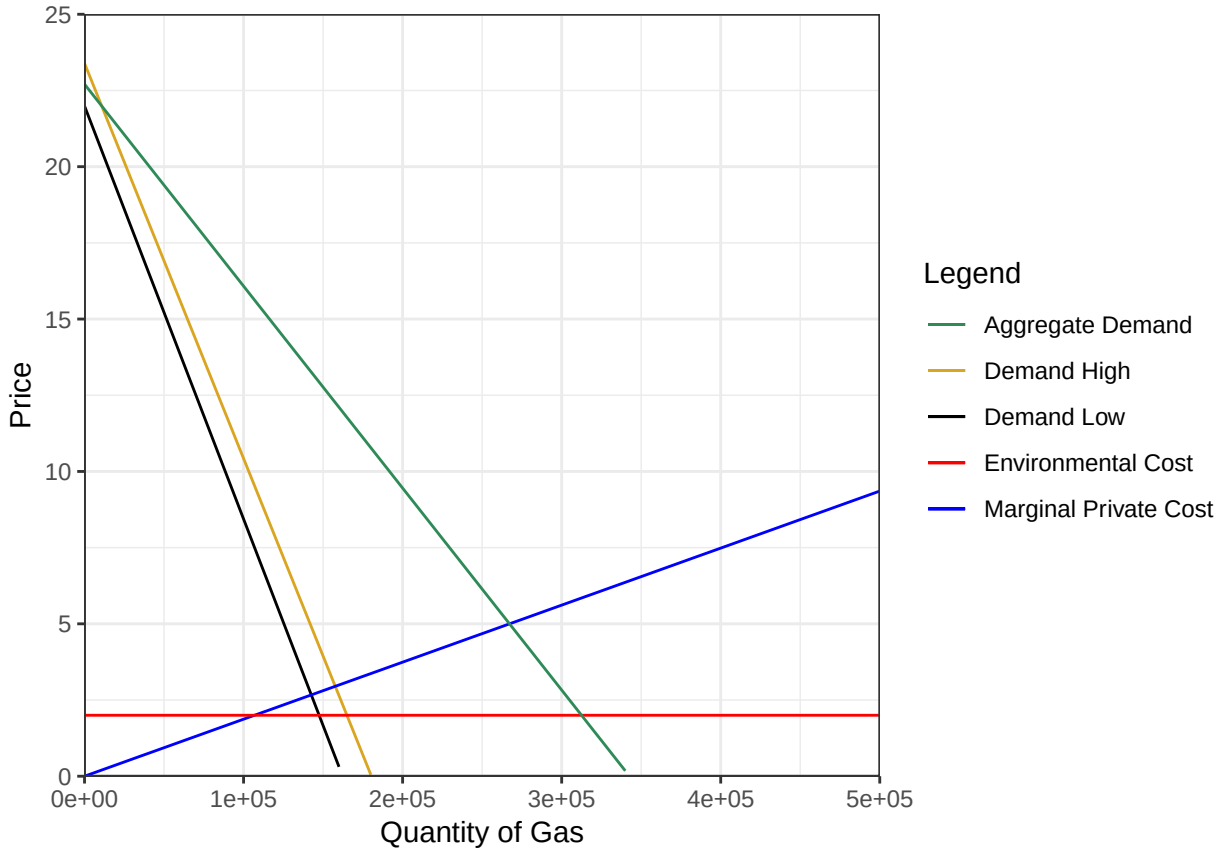
The demand curves for both groups were re-written to price as a function of quantity then added together to obtain the aggregate demand curve.

Aggregate demand curve:
$Price = 23.3913121Q$ *if 0 <= Q <= 10802*
$Price = 22.7066059 - (6.6262994 \times 10^{-5})Q$ *if Q > 10802*

b. Find the supply curve

Given the price of gasoline ($5) and the aggregate quantity consumed calculated above, the slope of the marginal private cost curve was derived and plotted with all other functions.

Supply curve:
$Price = (1.8711376 \times 10^{-5})Q$



c. Surplus under the status quo

Consumer surplus was calcualted by finding the area of the triangle bound by the line y = 5 (at the price of $5), the y axis and the aggregate demand curve

Producer surplus was calculated by finding the area of the triangle bound by the marginal private cost curve, the y axis, and the line y = 5.

Consumers:
$CS = 2.3694528\ Million\ USD$

Producers:
$PS = 0.6680428\ Million\ USD$

d. Environmental Cost under the Status Quo

Total environmental cost was calculated by multiplying the quantity consumed at market equilibrium under the baseline scenario by 2, the marginal environmental cost.

$Environmental\ Cost = 0.5344342\ Million\ USD$

2. Division of Consumer Benefit

Consumer surplus for each income group was calculated by finding the area of the triangles bound by each income group's demand curve, the line y = $5, and the y-axis.

Consumer Surplus for High Income:
$CS_{High} = 1.3043162\ Million\ USD$

Consumer Surplus for Low Income:
$CS_{Low} = 1.0651366\ Million\ USD$

3. Implement a Gas Tax of $0.50/gallon

a. New quantity of gasoline

A 0.50 tax would shift the marginal private cost by $0.50 vertically. The new quantity consumed under this scenario was found by setting the new mpc cost curve equal to the aggregate demand, and solving for q.

$Q_{Tax} = 2.6133299 \times 10^5$

b. New price of gasoline

$P_{Tax} = 5.3898999$

c. Surplus to high income consumers

$CS_{High} = 1.2495992\ Million\ USD$

d. Surplus to low income consumers

$CS_{Low} = 1.0168127\ Million\ USD$

e. Producer surplus

$PS_{Tax} = 0.6389461\ Million\ USD$

f. Environmental damage

$TEC_{Tax} = 0.522666\ Million\ USD$

g. Tax revenue

Tax revenue was calculated by multiplying the quantity consumed (in gallons) under this scenario by the tax, as the tax was applied per gallon of gasoline.

$Tax\ Revenue = 0.1306665\ Million\ USD$

4. Tax Revenues for Infrastructure Repairs

Tax revenues for infrastructure repairs are considered consumer surplus, as the consumers, aka the drivers, are the ones benefitting from the repairs. For this analysis, the amount of the tax revenue returned to each income group was calculated by assuming the benefit of improved infrastructure would be proportional to how much each group drives (in other words, their demand for gasoline).

a. Surplus to high income consumers

Table 1: High Income Consumer Welfare at Variable Gas Tax Amounts

Tax Amount	High Income Consumer Welfare (Million USD)
0.25	1.3119
0.50	1.3190
0.75	1.3257
1.00	1.3319
1.25	1.3376
1.50	1.3429
1.75	1.3477
2.00	1.3521
2.25	1.3560
2.50	1.3595
2.75	1.3625
3.00	1.3650
3.25	1.3671
3.50	1.3687
3.75	1.3698
4.00	1.3705
4.25	1.3708
4.50	1.3706
4.75	1.3699
5.00	1.3688

b. Surplus to low income consumers

Table 2: Low Income Consumer Welfare at Variable Gas Tax Amounts

Tax Amount	Low Income Consumer Welfare (Million USD)
0.25	0.5433
0.50	0.5554
0.75	0.5671
1.00	0.5783
1.25	0.5891
1.50	0.5995
1.75	0.6095
2.00	0.6189
2.25	0.6280
2.50	0.6366
2.75	0.6448
3.00	0.6525
3.25	0.6598
3.50	0.6667
3.75	0.6731
4.00	0.6791
4.25	0.6847
4.50	0.6898
4.75	0.6944
5.00	0.6987

c. Surplus to producers

Table 3: Producer Welfare at Variable Gas Tax Amounts

Tax Amount	Producer Welfare (Million USD)
0.25	0.6534
0.50	0.6389
0.75	0.6246
1.00	0.6105
1.25	0.5965
1.50	0.5827
1.75	0.5690
2.00	0.5555
2.25	0.5422
2.50	0.5290
2.75	0.5160
3.00	0.5032
3.25	0.4905
3.50	0.4780
3.75	0.4656
4.00	0.4534
4.25	0.4414
4.50	0.4295
4.75	0.4178
5.00	0.4062

Possible Revenues and Welfare Changes from Gas Tax:

Assumptions
- Benefits from infrastructure repairs are proportional to amount driven
- Low income consumers pay the entire environmental cost

Table 4: Comparison of Revenue and Welfare Potential with Variable Gas Tax Amounts

Tax Amount (USD)	Tax Revenue (Million USD)	Welfare Change Low Income (%)	Welfare Change High Income (%)	Welfare Change Producers (%)
0.25	0.0661	-48.9954	0.5811	-2.1899
0.50	0.1307	-47.8567	1.1270	-4.3555
0.75	0.1938	-46.7593	1.6377	-6.4969
1.00	0.2554	-45.7031	2.1133	-8.6141
1.25	0.3156	-44.6881	2.5537	-10.7070
1.50	0.3743	-43.7142	2.9589	-12.7756
1.75	0.4316	-42.7816	3.3290	-14.8200
2.00	0.4874	-41.8902	3.6640	-16.8402
2.25	0.5417	-41.0399	3.9637	-18.8361
2.50	0.5945	-40.2309	4.2283	-20.8078
2.75	0.6458	-39.4631	4.4577	-22.7553
3.00	0.6957	-38.7365	4.6520	-24.6785
3.25	0.7442	-38.0510	4.8111	-26.5774
3.50	0.7911	-37.4068	4.9351	-28.4521
3.75	0.8366	-36.8038	5.0238	-30.3026
4.00	0.8806	-36.2419	5.0774	-32.1288
4.25	0.9231	-35.7213	5.0959	-33.9308
4.50	0.9642	-35.2419	5.0792	-35.7085
4.75	1.0038	-34.8036	5.0273	-37.4620
5.00	1.0419	-34.4066	4.9403	-39.1912

5. Electric cars lower demand for each group by one half (vertically)

a. & b. Gas consumption by High/Low income Consumers

New demand curves for each group were derived by dividing the y intercepts by 2. These were then used to find a new aggregate demand curve. Setting the aggregate demand curve equal to the marginal private cost curve (with no tax) returned the new price of gasoline, which was then used to find the quantities consumed by each group.

Low Income Consumption:
$Q_{Low} = 6.2688822 \times 10^4$

High Income Consumption:
$Q_{High} = 7.0919736 \times 10^4$

Aggregate Consumption:
$Q_{Aggregate} = 1.3360856 \times 10^5$

c. New price of gasoline with higher EV use and lower gas demand

$Price = 2.5$

d. Environmental Cost

$Environmental\ Cost = 0.2672171\ Million\ USD$

6. Compare a 2.00 per gal tax to the influence of EV

Table 5: Environmental Cost Comparison

	Environmental Cost (USD)	Reduction (%)
Baseline	0.5344	0.000
$2.00 Gas Tax	0.4874	8.808
High EV Demand	0.2672	50.000