Calculating Deadweight Loss

Demand for gasoline and diesel are described using a constant elasticity demand function, $q = Ap^{\epsilon}$ with a scale parameter A that varies across countries and fuels, price p, and elasticity ϵ. In theory this should be the *compensated* demand elasticity (i.e. Hicksian) that reflects substitution but not income effects. However, most of the empirical literature has focused on estimating *uncompensated* elasticities. With gasoline and diesel, one would generally expect compensated elasticities to be smaller than uncompensated elasticities, which provides another reason for emphasizing the -0.6 rather than the -0.8.

This demand function is used to predict consumption under market prices and to calculate deadweight loss. Let p_0 and p_1 denote the subsidized price and market price, respectively and let q_0 and q_1 denote consumption levels corresponding to those prices. For an assumed demand elasticity, e.g., -0.6, and observed consumption level at the subsidized price q_0 it is straightforward to calculate the scale parameter for a given country and fuel. The demand function can then be used to predict consumption at the market price.

Deadweight loss can be calculated as the shaded area in Figure A2. Start with the rectangle $(p_1 - p_0)q_0$, and then substract off the area to the *left* of the demand curve between the subsidized price p_0 and market price p_1. This can be described with the following equation,

$$DWL = (p_1 - p_0)q_0 - \int_{p_0}^{p_1} Ap^{\epsilon} dp.$$

Evaluating the integral yields,

$$DWL = (p_1 - p_0)q_0 - \frac{A}{(1+\epsilon)}[p_1^{(1+\epsilon)} - p_0^{(1+\epsilon)}]. \quad (1)$$

Another, equivalent approach for calculating the same area is to start with the inverse demand function,

$$p = (A^{-1}Q)^{1/\epsilon}$$

and calculate the area *below* the demand curve between q_0 and q_1, and then substract this from the rectangle $(q_1 - q_0)p_1$,

$$DWL = (q_0 - q_1)p_1 - \int_{q_1}^{q_0} A^{-\frac{1}{\epsilon}} q^{\frac{1}{\epsilon}} dq.$$

Evaluating the integral yields,

$$DWL = (q_0 - q_1)p_1 - A^{-\frac{1}{\epsilon}}\frac{1}{\eta}[q_0^{\eta} - q_1^{\eta}]. \tag{2}$$

where $\eta = \frac{1}{\epsilon} + 1$.

It is helpful to go through an example. In Saudi Arabia the price of gasoline (p_0) in 2012 was \$0.61, and consumption (q_0) was 5,637 million gallons. Rearranging the demand function to solve for A yields,

$$A = q_0 {p_0}^{-\epsilon} = 5637 * 0.61^{0.6} = 4190.$$

So at the market price \$2.82 the demand equation implies that consumption would be equal to,

$$q_1 = A{p_1}^{\epsilon} = 4190 * 2.82^{-0.6} = 2241.$$

Thus this demand function implies that, in the long run, gasoline consumption would fall from 5,637 million gallons to 2,241 million gallons were prices to increase to \$2.82.

Using equation (1), deadweight loss is equal to,

$$DWL = (\$2.82 - \$0.61) * 5637 - \frac{4190}{(0.4)}[\$2.82^{(0.4)} - \$0.61^{(0.4)}] = \$5195.$$

Or, \$5.2 billion in deadweight loss in the gasoline market for 2012.

Using equation (2), deadweight loss is equal to,

$$DWL = (5637 - 2249) * \$2.82 - 4190^{\frac{-1}{-0.6}}\frac{1}{-2/3}[5637^{-2/3} - 2241^{-2/3}] = \$5195.$$

Or \$5.2 billion. As expected, both approaches yield the same measure for deadweight loss.

Table A1: Deadweight Loss in 2012, Top Ten Countries By Fuel

	Price per Gallon (Nov 2012)	Consumption in 2012 (millions of gallons)	Predicted Consumption at Market Price (millions of gallons)	Deadweight Loss in 2012 (billions)
	(1)	(2)	(3)	(4)
		Panel A. Gasoline		
Venezuela	$0.09	3786	470	7.8
Saudi Arabia	$0.61	5637	2241	5.2
Indonesia	$1.78	6002	3949	2.2
Iran	$1.25	5505	3379	2.0
Egypt	$1.70	1637	1050	0.7
Kuwait	$0.87	801	396	0.5
Libya	$0.45	385	129	0.4
Algeria	$1.10	797	453	0.4
Oman	$1.17	593	351	0.2
Bahrain	$1.02	216	102	0.2
		Panel B. Diesel		
Saudi Arabia	$0.25	4297	974	7.2
Iran	$0.47	4757	1560	5.9
Egypt	$0.68	1686	605	2.4
Venezuela	$0.04	845	65	2.1
Algeria	$0.64	1896	751	1.9
Indonesia	$1.78	3674	2343	1.6
Libya	$0.38	752	217	1.1
Ecuador	$1.10	690	377	0.4
Qatar	$1.02	519	271	0.3
Kuwait	$0.76	353	154	0.3

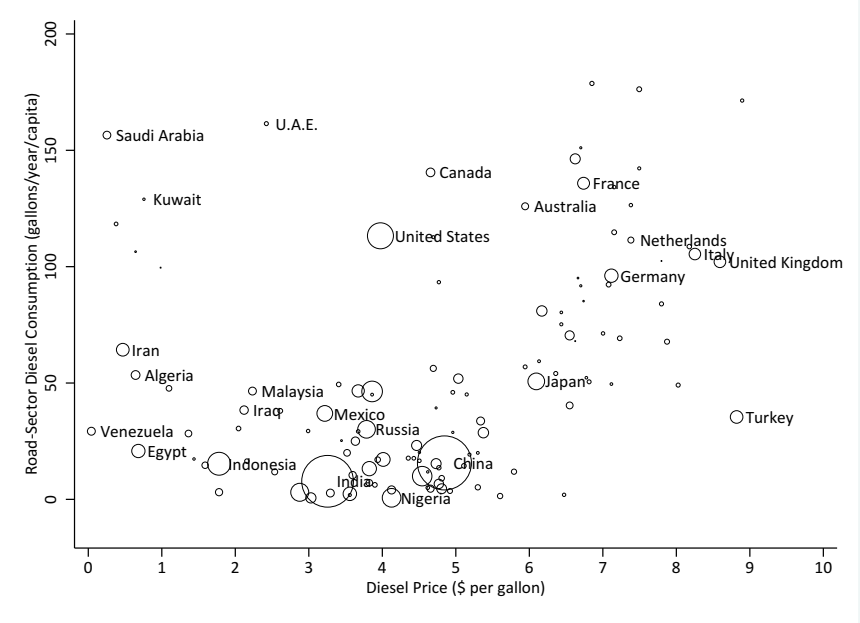

Figure A1: Diesel Consumption

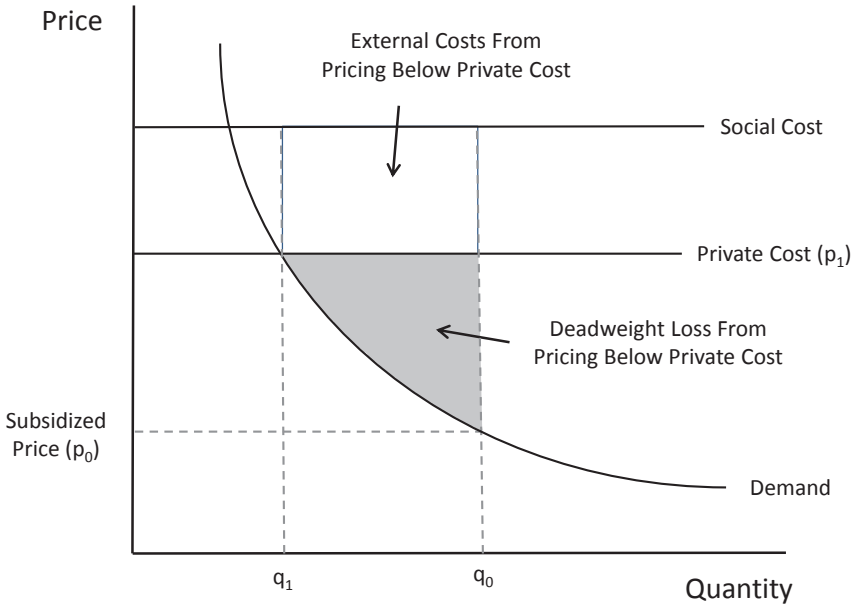

Figure A2: The Economic Cost of Fuel Subsidies

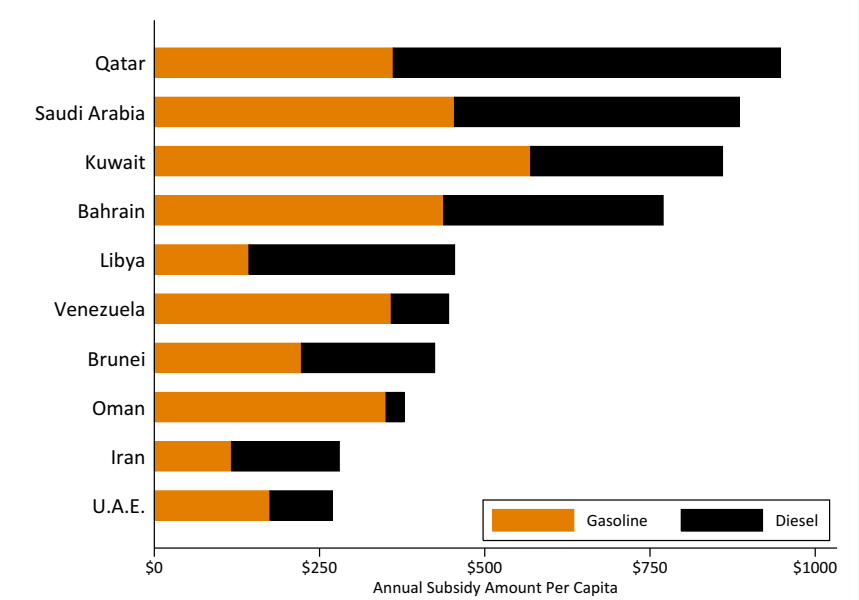

Figure A3: Fuel Subsidies Per Capita in 2012, Top Ten Countries

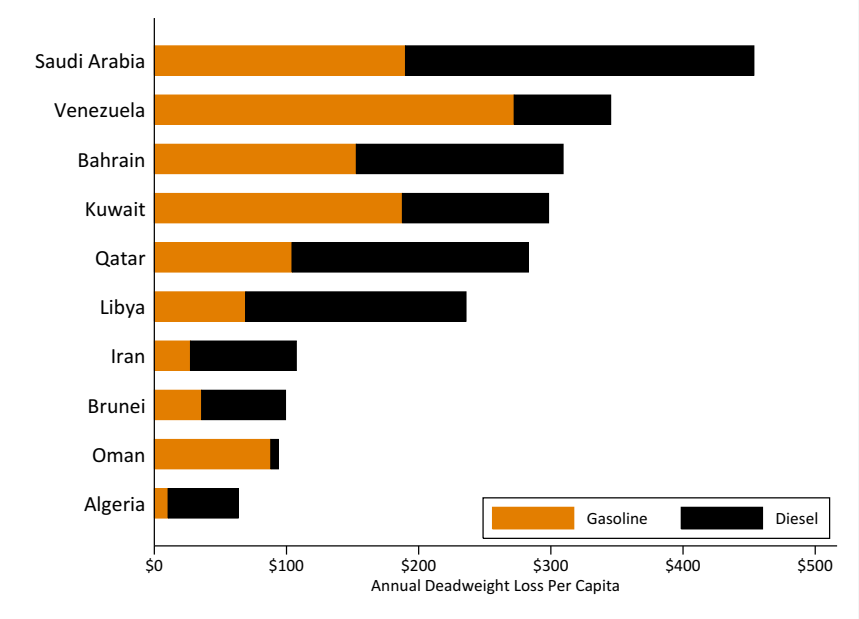

Figure A4: Deadweight Loss Per Capita in 2012, Top Ten Countries