Homework # 7 - [Due on November 2nd, 2018]

1. Consider a perfectly competitive industry with N symmetric firms, each with cost function $c(q) = F + cq$, where $F, c > 0$. Assume that the inverse demand is given by $p(Q) = a - bQ$, where $a > c$, $b > 0$, and where Q denotes aggregate output.

   (a) *Short-run equilibrium.* If exit and entry is not possible in the industry (assuming N firms remain active), find the individual production level of each firm.

   (b) *Long-run equilibrium.* Consider now that firms have enough time to enter the industry (if economic profits can be made) or to exit (if they make losses by staying in the industry). Find the long-run equilibrium number of firms in this perfectly competitive market.

2. A tax is to be levied on a commodity bought and sold in a competitive market. Two possible forms of tax may be used: In one case, a *per unit* tax is levied, where an amount t is paid per unit bought or sold. In the other case, an *ad valorem* tax is levied, where the government collects a tax equal to τ times the amount the seller receives from the buyer. Assume that a partial equilibrium approach is valid.

   (a) Show that, with a per unit tax, the ultimate cost of the good to consumers and the amounts purchased are independent of whether the consumers or the producers pay the tax. As a guidance, let us use the following steps:

      1. *Consumers:* Let p^c be the competitive equilibrium price when the *consumer* pays the tax. Note that when the consumer pays the tax, he pays $p^c + t$ whereas the producer receives p^c. State the equality of the (generic) demand and supply functions in the equilibrium of this competitive market when the consumer pays the tax.
      2. *Producers:* Let p^p be the competitive equilibrium price when the *producer* pays the tax. Note that when the producer pays the tax, he receives $p^p - t$ whereas the consumer pays p^p. State the equality of the (generic) demand and supply functions in the equilibrium of this competitive market when the producer pays the tax.

   (b) Show that if an equilibrium price p solves your equality in part (a), then $p + t$ solves the equality in (b). Show that, as a consequence, equilibrium amounts are independent of whether consumers or producers pay the tax.

   (c) Show that the result in part (b) is not generally true with an ad valorem tax. In this case, which collection method leads to a higher cost to consumers? [*Hint:* Use

the same steps as above, first for the consumer and then for the producer, but taking into account that now the tax increases the price to $(1+\tau)p$. Then, construct the excess demand function for the case of the consumer and the producer.]

(d) Are there any special cases in which the collection method is irrelevant with an ad valorem tax? [*Hint:* Think about cases in which the tax introduces the same wedge on consumers and producers (inelasticity). Then prove your statement by using the above argument on excess demand functions.]

3. Consider a national government seeking to regulate a polluting industry with firms operating in N regions (i.e., states or provinces). The cost of emission reduction in county i is $C_i(e_i)$, which is decreasing and convex in emissions, e_i. The environmental damage from emissions in region i is denoted by $D_i(e_i, E)$, which is increasing and convex in this region's emissions, e_i, and in aggregate emissions, $E = e_1 + e_2 + ... + e_N$, thus reflecting the presence of negative externalities of emissions across jurisdictions.

(a) *First-best policy (regionally differentiated fees).* Assume that the national government seeks to minimize the sum of aggregate costs of emission reduction along with aggregate environmental damages. (This is analogous to maximizing social welfare when output and emissions are unrelated, since both $C_i(\cdot)$ and $D_i(\cdot)$ enter negatively in the welfare function.) Find the emission fee that leads to the first-best level of emissions. Interpret.

(b) *Second-best policy (uniform fees).* Most emission fees in real life are not spatially differentiated. Assume that the national government imposes a uniform emission fee T on all regions. Find this emission fee and show that it can be expressed as the average environmental damage in all regions.

(c) *Comparison.* Under which case the uniform emission fee you found in part (b) coincides with that found in part (a), thus becoming socially optimal?