

## Problem set 3, International Trade

Domestic supply and demand are given by the curves  $S(p)$  and  $D(p)$ . *Domestic consumption* of the quantity  $D$  results in social environmental cost  $\gamma D$ .<sup>1</sup> This cost is external to consumers and producers. The country is small, and is able to trade on the world market at price  $p^w$ . The autarky price is  $\bar{p}$  in the absence of government regulation. The social welfare function is the sum of consumer and producer surplus, minus environmental damage plus any tax revenues (minus any program costs) that arise from government intervention. Where you are asked to use graphs, label the areas carefully. Where you are asked for an explanation, you should be brief (no more than a couple of sentences).

Draw figure 1 with linear supply and demand curves  $S(p)$  and  $D(p)$ , and social marginal value of consumption,  $p^{-1}(D) - \gamma$ , where  $p^{-1}$  is the inverse demand function.<sup>2</sup>

a) What is the first best policy (i.e., the policy that maximizes the sum of producer and consumer surplus minus environmental cost plus tax revenue) if there is no trade? In figure 1 label the consumer price without trade, under the first best policy, as  $p^a$ .

What is the first best policy if there is trade? (Remember, the country is small.)

b) Using figure 1, show what social welfare is in autarky, in the absence of any policy intervention.

c) (Assume no policy intervention.) Give a (simple!) sufficient condition for free trade to lead to higher social welfare than autarky, and *briefly* explain this sufficient condition.

d) (Assume no policy intervention.) Redraw the curves from figure 1, label it figure 2, and illustrate a case where the country is worse off under free trade than under autarky. In order to do this, experiment with the figure by picking world prices close to and far from the autarkic price. Find the circumstance under which trade decreases welfare.

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<sup>1</sup>The assumption that the environmental cost depends on *domestic* consumption is not innocuous. This is an example of the sort of detail that you should be aware of.

<sup>2</sup> The private utility of consumption is the area under the demand curve. Environmental damages are  $\gamma D$ , so the *social utility* of consumption is the area under the demand curve -  $\gamma D$ . At the optimum, the derivative of social utility of consumption, with respect to quantity consumed, equals the market price -  $\gamma$ . Note that I have defined the social utility of consumption. This is not the same thing as the social surplus. To obtain the social surplus I need to subtract the cost of production, i.e., the area under the supply curve.

As an alternative to this experimentation, you can proceed systematically. Define  $\Delta_1(p^w; \bar{p})$  as the increase in the sum of consumer and producer surplus resulting from trade when world price is  $p^w$  and define  $\Delta_2(p^w; \bar{p})$  as the increase in environmental damages resulting from trade. Graph  $\Delta_1$  and  $\Delta_2$  as functions of  $p^w$ . What is the shape of these graphs? Trade decreases welfare iff  $\Delta_2 > \Delta_1$ . The shape of the graphs will tell you the circumstance under which this inequality holds. (You should be getting the idea that many of these questions can be answered either by moving around curves on graphs or by using mathematics.)

e) Suppose that the (small) country is able to import at price  $p^w < \bar{p}$ , and that the only policy instrument is a tariff. Is the optimal tariff greater or less than the level of the first-best policy you identified in part (a)? Explain briefly. (I want you to think about the economic intuition before you approach the problem formally.)

f) Graph the import demand curve in a new figure; label it  $M(p)$ . Write the expression for social marginal benefits (smb) of imports, and graph it in the same figure, labeling it as  $smb(p)$ . Pick a world price lower than the intercept of  $smb(p)$ . Using this figure show the optimal tariff.

Alternatively, you can derive the optimal tariff using algebra. If you use algebra, you need a bit of notation. Define  $W(p)$  as the total social gains from imports as a function of the domestic (tariff inclusive) price. That is, hold the world price fixed and think of varying the domestic price. For a fixed world price, varying the domestic price is equivalent to varying the tariff.  $W(p)$  equals: the increase in consumer surplus, minus the decrease in producer surplus, plus the tariff revenue, plus the reduction (or minus the increase) in the environmental cost.) Find the expression for  $W(p)$ , in terms of the supply and demand curves and the environmental cost. Set the derivative of  $W(p)$  equal to 0, and use this first order condition to find the optimal price.

g) Suppose that our country is "large", i.e. it faces an upward sloping world excess supply curve for the good. Provide a *very brief* verbal explanation for whether this monopsony power increases or decreases the optimal tariff in part f.

Using the graphical method from part f, find the optimal tariff for a large importer.

h) Now suppose (as in part g) that the country is large, and also that the environmental damage it suffers depends on aggregate world consumption of the good - not just on domestic consumption. Explain whether this change increases or decreases the optimal tariff from part g.