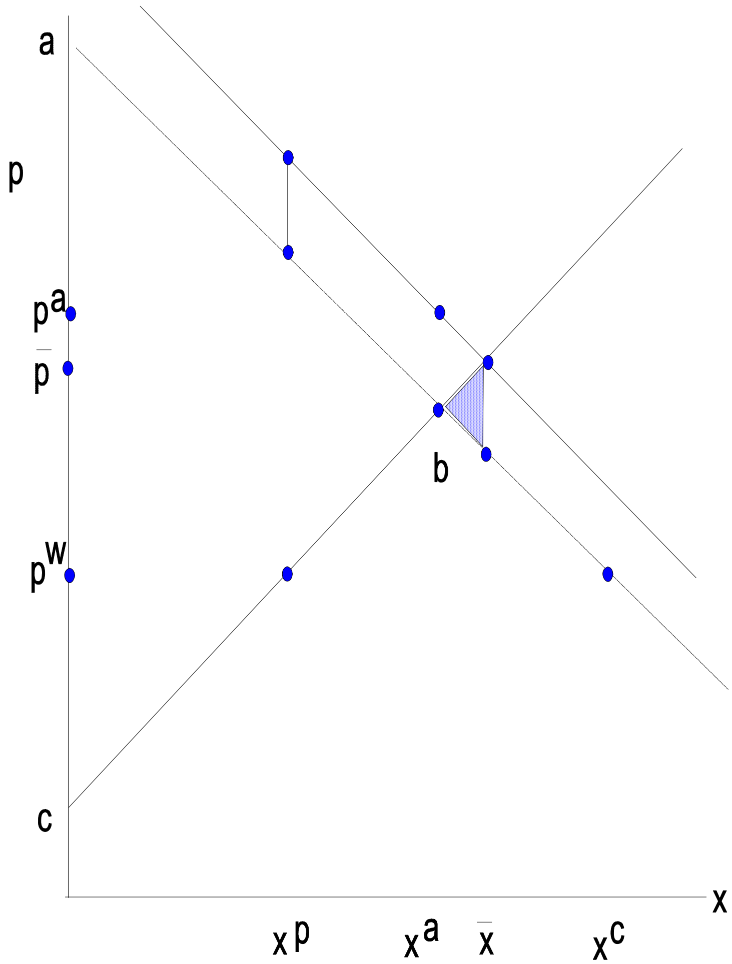
December 2008

Solution to problem set #4



Question 1

a) In autarky, without intervention, the price is at $\bar{p}$ (the intersection of Supply and Demand, the two solid lines in Figure 1)) and consumption and production equal $\bar{x}$. At that point, the social marginal value of consumption $\bar{p} - \gamma$, is less than the marginal cost of production, $\bar{p}$. The optimal level of consumption under autarky, x^a, can be achieved with either a consumption or a production tax of γ. In autarky, consumption = production, so it doesn't matter which group directly pays the tax. The consumer price is p^a and the producer price is $p^a - \gamma$, whether a production or consumption tax is used. Note that this result is merely an example of the general result that, in a closed economy, it does not matter which group (consumers or producers) directly pays the tax. The reason is that, in a closed economy, the price that the producer receives and the price that the consumer pays does not depend on which group directly pays the tax.

Now consider trade, and suppose that the country is an importer, so p^w is below the autarkic price (Figure 1). With trade, production $\neq$ consumption. Since the "distortion" arises from consumption, it is important to target consumption rather than production. Domestic producers should face the world price, causing them to produce x^p, and consumers should face a consumption tax of γ, so that they pay $p^w + \gamma$. (Confirm that the policy recommendation does not change if the country is an exporter.)

Note that for a small country that trades in equilibrium, the price that consumers face is independent of a tax/subsidy applied to domestic producers. When producers are taxed/subsidized, consumers pay the world price. Thus, a tax/subsidy for producers does not affect the level of consumption -- which is what the policymaker wants to influence.

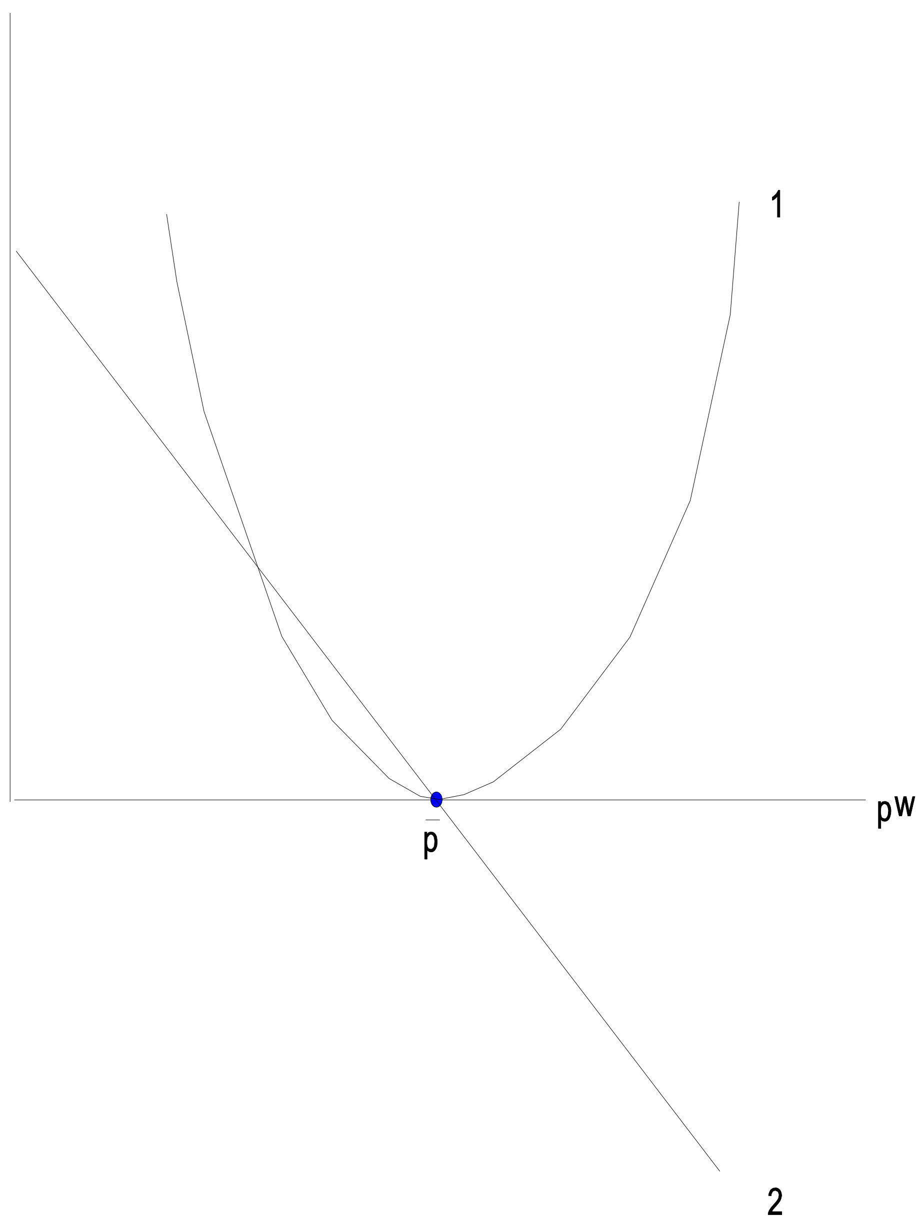
b) Subtract the environmental cost $\gamma\bar{x}$ from the sum of consumer and producer surplus, leaving the triangle abc minus the small shaded triangle.

c) If the country exports the commodity, i.e., the world price is above the autarkic price, it obtain s the usual gains from trade, and also reduces the environmental cost because consumption falls.

d) When the country begins to trade, domestic price falls from $\bar{p}$ to p^w. The change in the sum of producer and consumer surplus is Δ_1 and the increased environ mental cost is Δ_2, with

Δ_1

Δ

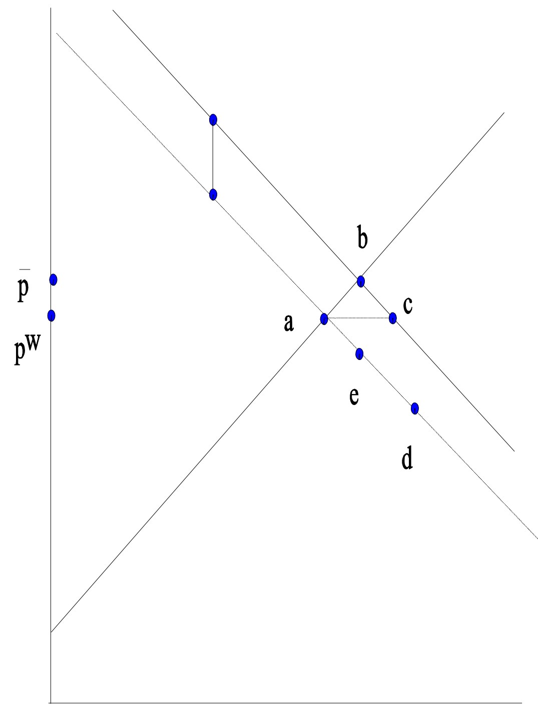


For the country to be worse off from trade, we need $\Delta_2 > \Delta_1$. Y ou should be able to show that Δ_1 is a con vex function of p^w w hich (in the absence of regulation) reache s its minimum at $\bar{p}$ (the autarkic price w ith no government re gulation) and that Δ_2 is a decreasing functi on of p^w, with $\Delta_2(\bar{p};\bar{p}) = 0$. See figure 2. Therefore, for p^w slig htly less than $\bar{p}$, $\Delta_2 > \Delta_1$.

Here's another way t o say the same thing: The gains from trade (including additional environmental dama ges) are $G(p^w) \equiv \Delta_1(p^w) - \Delta_2(p^w)$. Note tha t $G(\bar{p}) = 0$, i.e, if the autarkic and world price are equal, there are no gains from trade. Also, $dG(\bar{p})/dp^w = 0 - \gamma D'(\bar{p}) > 0$, so when p^w is slightly below $\bar{p}$, the gains are negative.

(The notation $dG(\bar{p})/dp^w$ means the derivative of G with respect to the world price, evaluated wh ere the world price equals the autarkic price.)

Figure 3 shows a situation where Δ_2 = bcde > abc = Δ_1, so the net gains from trade are negative.[1]



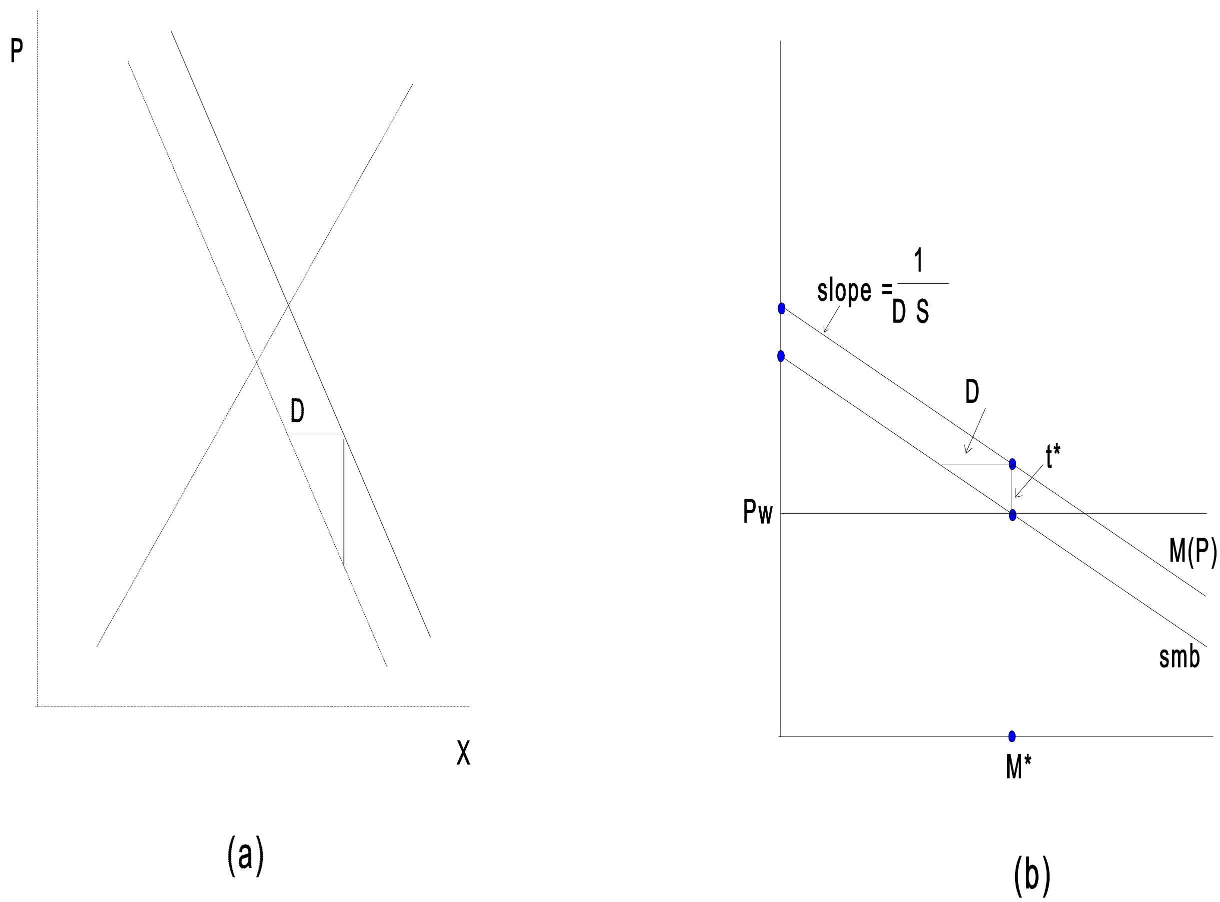
e) The optimal tariff must be lower than the first-best tax, since the tariff introduces a (secondary) distortion in production. In other words, correcting the environmental distortion carries a cost.

f) The gains from being able to trade (import) at price p, as we saw above, are $G(p) = \Delta_1(p) - \Delta_2($

[1] Here is an answer to the question “How can I show negative gains from trade graphical ly?” One way is to show that the area that measures the loss is greater than the area that measure s the gains, as in the paragraph in the text. Another method is to note that (for an importer) the g ains from trade is the area below the social marginal benefit from imports, above the world price line, from quantity = 0 to the equilibrium quantity. In the absence of an externality, the social m arginal benefit from imports is equal to the excess demand curve, but with the externality discuss ed in this problem set, the social marginal benefit of imports lies below the excess demand curve. (See figure 4.) Under autarky, imports are greater than the level that equates social marginal be nefits (smb) of imports and the price of imports. So the area “under the smb curve, above the pri ce line, from quantity =0 to the equilibrium quantity” includes ‘negative area’.

p), so the social marginal benefit of imports (as a function of price) is $smb(p) = -dG/dp = -[S(p) - D(p) - \gamma D'(p)] = M(p) + \gamma D'(p) < M(p)$, where $M(p)$ is the excess (import) demand function, $D(p) - S(p)$. The reason for the negative sign in front of dG/dp is that an increase in world price decreases imports, and we want to measure how welfare changes when imports increase. So we know that the social marginal benefit curve lies below the import demand curve.

From figure 4b we see that the optimal level of imports, M*, equates social marginal benefits and world price. This level of imports is supported by a tariff of t*. From construction of smb and figure 4a, we know that the horizontal difference between M(p) and smb is $\gamma D'$. Also, the slope of M(p) is $1/[D'-S']$. Using the "rise over run" formula for slope, we know that $t^* = \gamma[D'/(D' - S')$



$< \gamma$. This confirms the result we obtained from intuition in part e.

Now here is the algebra. Define W(p) as the *total* social gain from trade. W(p) equals the gains from trade defined above (additional consumer + producer surplus minus additional pollution damage), plus tariff revenues [which equals $(p - p^w)\cdot(D - S)$]: $W(p) = G(p) + (p-p^w)\cdot[D(p) -S(p)]$. The second term is tariff revenue. Here p is the import price. The world price, p^w, is assumed fixed (because of the small country assumption), so $p - p^w \equiv t$ is the *unit tariff*. The mathematical problem is $\max_p W(p)$. The first order condition is $G'(p) = -(D - S) - (p - p^w)(D' - S')$, i.e.

$-\gamma D'(p) + (p-p^{w})[D' - S'] = 0.$

Solving this equation, using $p - p^{w} \equiv t$ gives the optimal t: $t = \gamma D'/[D' - S'] < \gamma$. We obtained this result above using geometric arguments. (Look at figure 4b again. Using the "rise over run" relation, $t^*/\gamma D' = 1/(D' - S') \Rightarrow t = \gamma D'/[D' - S']$, which is the same formula we obtained algebraically.)

g) Monopsony power increases the incentive to restrict imports and therefore leads to a larger tariff.

h) This change decreases the optimal tariff, because now the tariff provides less of a "cure" for the environmental externality. Decreased domestic consumption, resulting from the tariff, causes a fall in world price and an increase in consumption abroad, which results in a domestic cost.