1. Consider the case of two large countries:

**US:** Demand \( = 150 - 10P^w_s \) Supply \( = 20P^w_s \) where \( P^w_s \) is the price of soybeans in the US;

**China:** Demand \( = 300 - 10P^c_s \); Supply \( = 10P^c_s \) where \( P^c_s \) is the price of soybeans in China;

(a) **Find autarky prices:**

**US:** \( S^w - D^w = 30P^w_s - 150 = 0 \rightarrow P^w_s = 5 \)

**China:** \( S^c - D^c = 10P^c_s - (300 - 10P^c_s) = 20P^c_s - 300 \rightarrow P^c_s = 15 \)

(b) **Assuming free trade (no tariffs), find the equilibrium price and quantities traded.**

World equilibrium requires: \( (S^w - D^w) + (S^c - D^c) = 0 \rightarrow 30P^w_s + 20P^c_s - 450 = 0 \)

Free trade implies: \( P^w_s = P^c_s = P^w \) (world price).

Combining the above two equations implies: \( 50P^w_s - 450 = 0 \rightarrow P^w_s = 9 \)

US exports = Chinese imports = \( (S^w - D^w) = 30P^w_s - 150 = 120 \)

(c) **Show how a US import tariff of \( t \) affects the volume of trade, prices in China and the US, and US welfare. Who pays for the US tax? Explain.**

Drop the subscript (s) for soybeans, for simplicity: the US export tariff implies: \( P^c = P^w + t \) if the product is to be sold in both the US and China. This equation, together with the world supply = world demand equation implies:

\[
30P^w + 20P^c - 450 = 0 \rightarrow 30P^w + 20(P^w + t) - 450 = 50P^w + 20t - 450 = 0 \rightarrow P^w = 9 - (2t/5)
\]

\( P^c = 9 + (3t/5) \)

Thus, even though the US imposes the tax, only \( (2/5) \) is paid by US citizens while \( (3/5) \) is paid by Chinese citizens. There is “partial incidence” of the tax. To calculate the welfare consequences for the US consider the figure below:
(i) Because the tariff decreases US price, consumers gain area $(9, A, A^*, (9-2t/5))$ and producers lose area $(9, B, B^*, (9-2t/5))$. Calculating these areas gives:

$$\Delta CS = (2t/5) \left( \frac{120 + 4t}{2} \right) = 24t + (4/5)t^2;$$

$$\Delta PS = -(2t/5) \left( \frac{360 - 8t}{2} \right) = -72t + (8/5)t^2$$

On the other hand government tariff revenue is $tX = t(120 - 12t)$, which is area $\{J, K, B^*A^*\}$. Hence, the overall welfare impact is:

$$\Delta W = Area \{J, K, M, L\} - Area \{A, L, A^*\} - Area \{B, M, B^*\} = Rectangle 3 - Triangle 1 - Triangle 2$$

The last two areas are the familiar losses due to overconsumption and underproduction in the US due to the export tariff. **What is new is the first area** – which represents the gains to the US because China is paying the US more for soybeans – i.e., the increased price times the amount exported at the price. This gain to the US is a loss to China – a transfer from China to the US because China pays part of the US tax. In terms of the numbers given here:

$$\Delta W^{itr} = Tariff\ Revenue + \Delta CS + \Delta PS = 120t - 12t^2 + 24t + (4/5)t^2 - 72t + (8/5)t^2 = 72t - (48/5)t^2$$

The US gains from any tariff such that $\Delta W > 0 \Rightarrow 0 < t < (360/48) = 7.5$.

(ii) For $t=5$, US price falls by 2, Chinese price rises by 3, US consumer surplus increases by 140, US producer surplus decreases by 320, US exports are 60, US tariff revenue is 300 and the change in US welfare is: $\Delta W = 140 - 320 + 300 = 120$. Clearly the US gains from the export tariff.

(iii) What would happen if the export tariff of 5 were replaced by an export quota of 60 units?
With an export quota of 60, if it binds, we have:

**US:** \( S^{au} - D^{au} = 30P^{au} - 150 = 60 \rightarrow P^{au} = 7; \)

**China:** \( D^c - S^c = 300 - 20P^c = 60 \rightarrow P^c = 12 \)

Thus, with US exports limited, there would be a price gap of 5 between US and Chinese prices. Whoever had the right to export from the US (the holders of the quota licenses) would make excess profits of 5.

Thus, the only difference between the tariff of 5 and the export quota of 60 is that the government revenue under the tariff becomes excess profits for the exporters under the quota. If the quota is auctioned off, then the two policies are equivalent.

(iv) **Find the US export tariff that maximizes US welfare.**

From part (i) above we have: \( \Delta W = 72t - (48/5)t^2 \)

Maximizing with respect to \( t \):

\[
\frac{d(\Delta W)}{dt} = 72 - \frac{96}{5}t = 0 \rightarrow t^* = \frac{360}{96} = 15
\]

As stated above, free trade is not optimal for the US because its policies affect world price. Thus, it has the ability to act like a monopolist on world markets. But, as with monopoly, even though the monopolist can increase (its own) profits by restricting output, the loss to consumers exceeds the gains to the firm – there is a deadweight loss. The same is true of the US export tariff – the loss to the Chinese exceeds the gains to the US, creating a deadweight loss from the tariff.

(d) **Show how the US tariff affects Chinese welfare.**

For the Chinese there is no tariff revenue, so the higher world prices they face results in lower welfare. Breaking it down by producers and consumers:

![Diagram](image-url)

**Impact on China of US export tariff**
The US export tariff causes world price (and hence Chinese price) to increase from 9 to $9 + (3/5)t$. This causes Chinese consumption to fall, production to increase, and imports to decrease. The welfare impact on each group is:

\[
\Delta PS = Area\{9, A^*, A, (9 + (3/5)t)\} = \frac{3t}{5} \cdot (90 + 3t)
\]

\[
\Delta CS = -Area\{9, B^*, B, (9 + (3/5)t)\} = -\frac{3t}{5} \cdot (210 - 3t)
\]

\[
\Delta W^c = \Delta PS + \Delta CS = -72t + \frac{18t^2}{5}
\]

In terms of the figure, the deadweight loss to China is $Area\{A^*, A, B, B^*\} = Rectangle\ 3 + triangle\ 4 + triangle\ 5$.

If you compare the figures for the US and China, you see that area “3” is a transfer from China to the US because of higher export prices, while triangles 1 & 2 for the US, and triangles 4 & 5 for China measure the overall inefficiency (or deadweight loss) due to the US policy. In terms of equations:

\[
\Delta W^u + \Delta W^c = \Delta W = (72t - (48/5)t^2) + (-72t + (18/5)t^2) = -6t^2 < 0, \quad t > 0
\]

i. A Chinese import tariff, by raising domestic prices in China, would reduce the demand for imports and thus lower the world price of soybeans. Thus, just as the US gains from an export tariff, China can gain from an import tariff. But note that, in each case, the benefits to the winner are smaller than the losses to the loser. Hence, it is possible that each country tries to act as a monopolist (a monopolist in the case of China, since it is a buyer), but by doing so both countries are worse off. However, neither country has the incentive to unilaterally end its tariff.

(e) How does the tariff affect world welfare?

As shown in part (d), it leads to a decline in world welfare because the volume of trade falls and a wedge is driven between production costs in the US and China, and the value to consumers in the two countries of soybeans.

i. Why doesn’t the US unilaterally eliminate its tariff?

The simple point is that what is good for the world as a whole need not be good for the US without compensation. Thus, if the US unilaterally eliminates its tariff, the US loses even though China gains even more. Without compensation of some sort, the US will be unwilling to lower tariffs. This is one reason why tariffs are often reduced as a result of international agreements rather than lowered unilaterally by countries (especially for larger countries. Smaller countries, with no ability to affect world prices, do not have the same incentive to maintain trade barriers).

2. Free Trade Area. Consider the computer industry; Mexico has following Supply and Demand:

\[S = 3p^d; \quad D = 6000 - p^d\]

Mexico can import (identical) computers from US at $p^u = 900$ or from Japan at $p^j = 700$.

Mexico is small and does not affect world prices.
a) Initially, with $t = 300$ regardless of origin of imported computers:

Mexico imports from Japan; $P^{mex} = P^J + 300 = 1,000$

Hence: $Q^{mex} = 3p^d = 3000$; $D = 6000 - p^d = 5000$; $M^d = D - S = 2000$

b) Mexico forms FTA with US. Since there are no taxes on US computers, imports from US cost Mexican consumer 900, those from Japan 1000. **Hence, imports come from US.**

$p^d = P^{mx} = 900$; $S^m = 2700$; $D^m = 5100$; $M^m = 2400$

**Mexican production falls, consumption increases, imports increase. Volume trade increases by 400 (from 2000 to 2400) – this is trade creation;** but all imports come from US rather than Japan – this is trade diversion. To see welfare, consider diagram:

Consumers **gain:** Area $\{1000,B^*,B,900\} = 100*5050 = 505,000$

Producers **lose** Area $\{900,A^*,A,1000\} = 100*2850 = 285,000$

Government **loses** tariff revenue $= 300*2000 = 600,000$ (Area ABHJ)

**Net Loss** $= 380,000$

This net loss is the gain from trade creation (triangles $\{A^*,A,V\}$ and $\{B,B^*,W\}$) minus the loss due to trade diversion (area $\{V,W,H,J\}$) - which reflects the higher costs paid for the original level of imports (2000 units) from the US rather than from Japan.

(c) If the tariff were originally $600 per unit (instead of $300 per unit), then before the FTA the price of Japanese imports in Mexico would be $1300, and all imports would come from Japan. So:

Pre-FTA: $P^{mex} = 1300$; $Q = 3900$; $D = 4700$; Imports = 800;

Tariff revenue $= 480,000$ (see figure below)
After the FTA, the tariff on US goods is eliminated and imports come from US. The post-FTA situation is the same as in (b):

Post-FTA \( P_{\text{mex}} = 900; \quad Q = 2700; \quad D = 5100; \quad \text{Imports} = 2400 \)

Thus, the amount of trade creation is much larger than in (b), and the amount of trade diversion is smaller. Hence, the net loss should be smaller (or the net gain larger). To measure it, see figure below:

Consumers gain: Area \( \{900,B^*,T,1300\} = 1,960,000 \)
Producers lose: Area \( \{900,A^*,S,1300\} = 1,320,000 \)
Government loses tariff revenue = 480,000 (Area STLM)
Net welfare gain = \( \boxed{160,000} \)

This welfare gain equals the gains from trade creation (the triangles \( \{A^*,S,J\} \) and \( \{K,T,B^*\} \)) less the loss from trade diversion (area \( \{J,K,M,L\} \)) due to the fact higher priced imports from the US replace imports from Japan.

So, joining the FTA benefits Mexico in case (c), but not in (b). Explanation: trade creation in (c) is larger as imports increase from 800 to 2400, whereas in (b) imports increase only by 400. In both cases trade diversion occurs, as imports from Japan that previously cost $700 to the country (remember the tariff revenue goes to the Mexican government) are diverted to imports from the US, which cost $900. This trade diversion is much larger in (b), where imports are originally 2,000 because of the lower tariffs, than in (c), where imports are only 800. Moral: \textit{even if lowering all tariffs is good, it does not automatically follow that lowering some tariffs will improve welfare.}