# Problem Set 4 - *Answers*

Specific Factors and Government Policies

1. In the Extreme Specific Factors Model,
    a. What does a country's excess demand curve look like?
        The PPF in the Extreme Specific Factors Model is just a point $\overline{X},\overline{Y}$ in goods space (X,Y space). Excess demand and supply are just the difference between this point and the tangencies of indifference curves with various price lines:
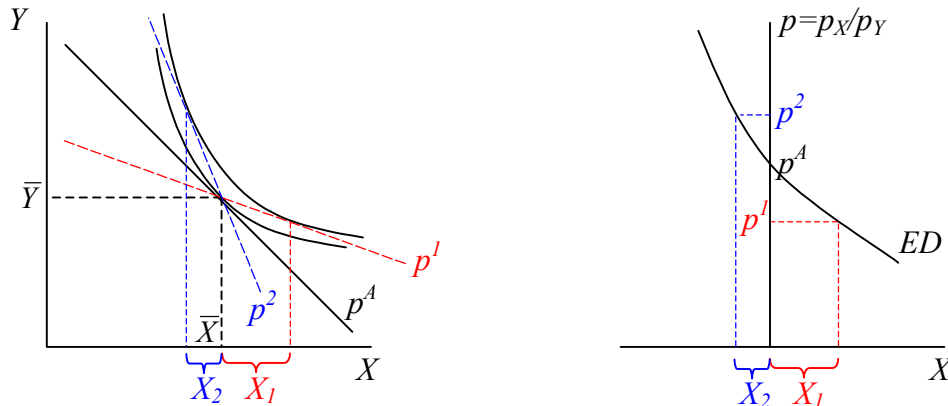
    b. What determines the relative price at which the excess demand curve crosses the vertical axis?
   *This is the autarky price, of course, and it is given by the slope of the indifference curve passing through $\overline{X},\overline{Y}$.*

    c. Suppose a world of two countries that are trading freely, with the home country importing good *X,* and exporting good *Y* to Foreign. Suppose now that Home (only) experiences an improvement in its technology so that the factors employed in its *X* industry become more productive by, say, 10%. What will this do to
        i)   its excess demand or supply curve,
        ii)   the world equilibrium relative price of *X,*
        iii)   the real wage of labor in Home's *X* industry
        iv)   the real rental price of capital in Foreign's *Y* industry?
        This will increase $\overline{X}$ by 10% without changing $\overline{Y}$. For any given price, this will increase income, causing consumption of both goods to increase (assuming they are normal goods). In order for consumption of Y to increase, however, consumption of X cannot rise by as much as $\overline{X}$. Therefore, for any price, the

*country's excess supply of X increases and its excess demand decreases, shifting
its ED curve to the left throughout its length, as shown below. This, in turn,
causes the world equilibrium relative price of X to fall, as also shown.*
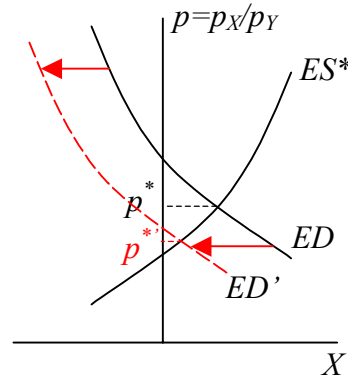

*In the Home X industry, labor is paid the value of its marginal product. That
marginal product has increased by 10% due to the improved technology, so
labor's wage in units of X has gone up by that amount. However, the price of X
has fallen, and we don't know by how much. If the price falls by less than 10%,
then this is necessarily an improvement in its real wage. But if it falls by more
than 10%, which it may (depending on the elasticities of the various curves),
then workers in the Home X industry can buy less of Y, and may be made worse
off if their demand for Y is a large enough part of their budgets. Thus the effect
on the wage in the Home X industry is ambiguous.*

*As for capital in the Foreign Y industry, its marginal product has not changed,
so it is paid the same in terms of Y. But that payment is worth more in terms of
X, due to the price change, so its real payment has increased.*

2. In the (Standard) Specific Factors Model of a small open economy that initially
    exports good X, analyze the effects on

    i)   outputs of the goods, X and Y,
    ii)   the real wage of labor,
    iii)   the real rental price of capital in the X industry, and
    iv)   the quantity of X exported
    due to the following changes (one at a time):

    a. A fall in the price of good Y, holding the price of good X constant.
        *The fall in price of good Y causes the Y industry's value of marginal product of
        labor curve, $VMP_{LY}=p_Y MP_{LY}$, to shift down, as shown below. Labor market
        equilibrium is found at a lower nominal wage, w', with an increase in the
        amount of labor employed in the X industry and a decrease in L_Y. Therefore,
        output of X rises and output of Y falls, moving the country down and to the right
        on its PPF.*

The effect on the real wage is ambiguous. It has fallen in nominal terms, and therefore with respect to the price of X, which has not changed. But the price of Y has fallen, and the wage would have to have fallen to w_0 shown below to equal that fall in price (since that is the amount that the p_yMP_{LY} curve has fallen), and it hasn't done that. So w/p_X is down, but w/p_y is up.
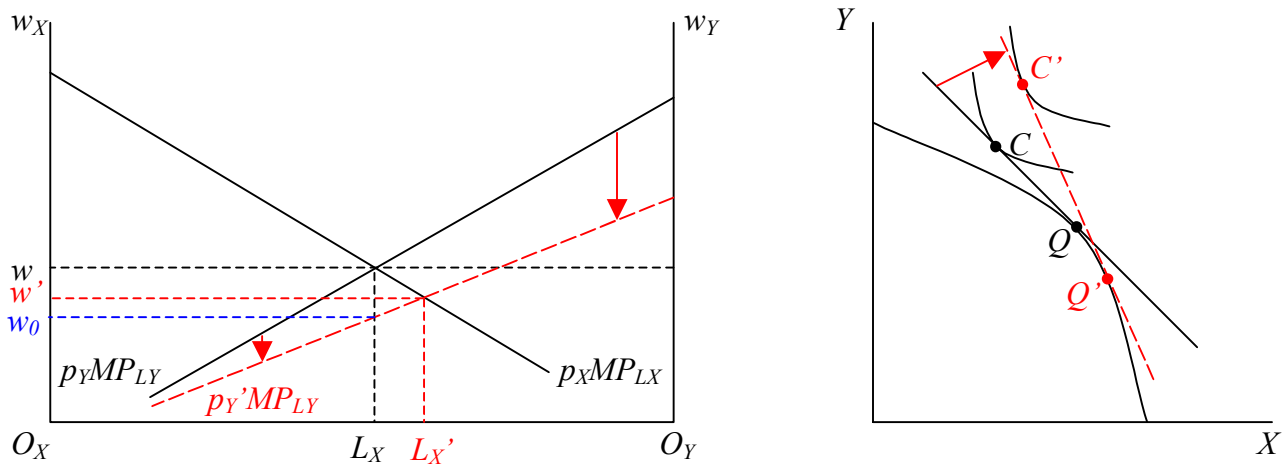
Nominal payments to capital in the X industry have increased, since the increase in L_X increases capital's marginal product (or note the increased area below VMP_{LX} above w'). Since p_X is unchanged and p_Y has fallen, this is a real increase.

Looking at output and consumption in the PPF diagram, we see that output of X has increased, while consumption of X may have risen or fallen (it is shown having risen) depending on income and substitution effects. Without any assumption about preferences, we can't be sure that exports of X increase.

b. An increase in the size of the labor force.
    This expands the diagram horizontally, since its horizontal dimension is the labor endowment. It is drawn below keeping the O_X origin fixed, and therefore shifting to the right both the right-side vertical axis and the VMP_{LY} curve, since that is drawn with respect to that axis. The result is that the intersection with the unchanged VMP_{LX} curve also moves right, but not as much, and occurs at a lower w.

    This fall in the wage, holding prices and capital stocks fixed, requires a fall in the marginal product of labor and therefore that employment expands in both industries. Thus output rises in both industries. The fall in the wage is a real decline, since both prices are fixed. And the increased employment increases the returns to capital in both sectors, also in real terms since prices are fixed.

*Here again we cannot be sure what happens to exports, since both production
and consumption of X expand.*
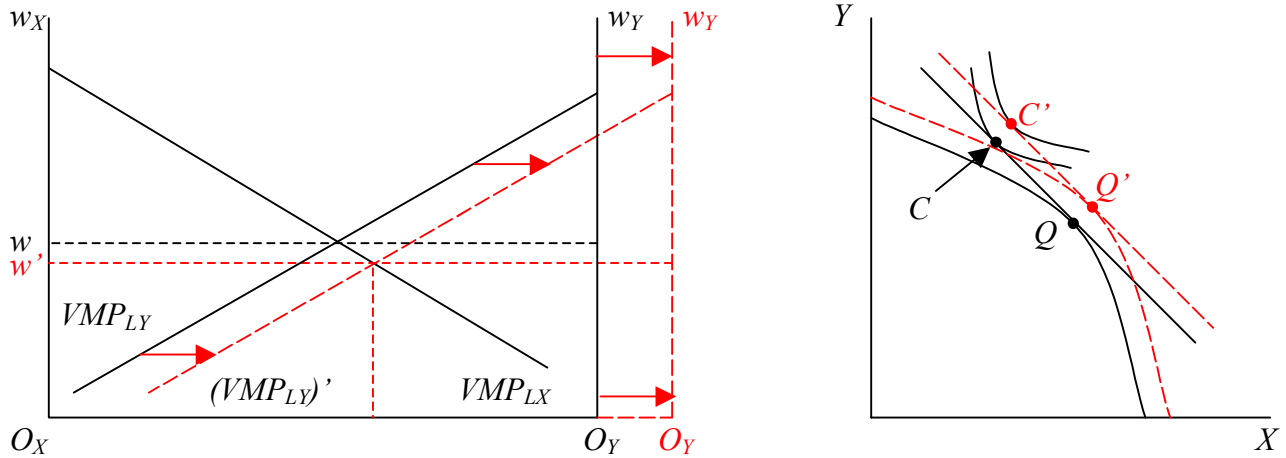
c. Destruction of a part of the capital stock employed in the *Y* industry.
*This reduces the marginal product of labor in the Y industry, shifting the VMP_{LY}
curve down. The labor-market diagram looks the same as in part (a), except
that the curve has shifted due to changing the MP_{LY} function instead of changing
p_Y. This time, however, the PPF is shrunken inward, since less of Y (but not X)
can be produced. In fact, from the labor-market diagram we see again that
since L_X increases, output of X rises. Output of Y falls, of course, both because
of the loss of capital and then also because of the fall in L_Y as labor also leaves
the industry.*
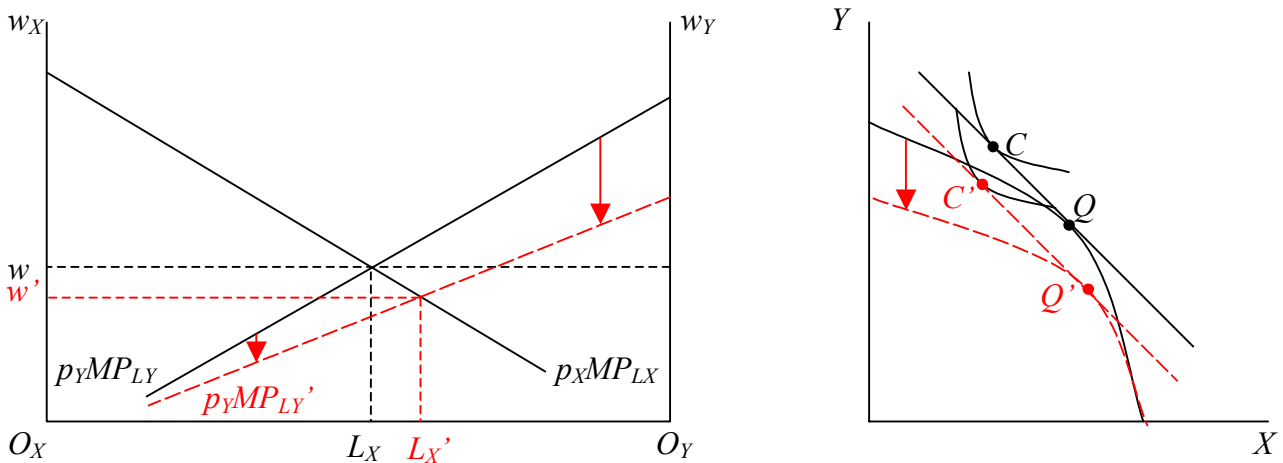
*The real wage falls, because the nominal wage falls and prices have not
changed.*

*Capital that survives in the Y sector actually gains, though this is a bit hard to
see. Since w has fallen with no change in p_Y, MP_{LY} must have fallen. But
marginal products depend on the ratio of capital to labor, so K_Y/L_Y must have
fallen. This in turn means that MP_{KY} must have risen, and therefore that r_Y has
gone up. Since p_X is also unchanged, this is a real increase.*

*This time we can say what happens to exports. The fall income reduces
consumption of X (if X is normal), while the output of X has increased.
Therefore exports of X rise.*

3. Consider the Heckscher-Ohlin Model of a small open economy that produces labor-
    intensive good *X* and capital-intensive good *Y,* and that imports good *Y.* Find and
    compare the effects of i) a production subsidy for good *X*, and ii) a consumption
    subsidy for good *Y* on
    a) Output of *Y*
    b) Imports of *Y*
    c) Real wage of labor
    *A production subsidy for good Y, s_Y^P, causes producers of Y to receive payment both
    from purchasers of their product (domestic or foreign) and from the government, so
    that the price paid by consumers, q_Y, is less than the price received by producers by
    the fraction of the subsidy: $q_Y = (1 - s_Y^P)p_Y$. With no tax or subsidy on good X,
    $q_X = p_X$, so that, since consumers face world prices p^*,*

$$p^* = \frac{p_X^*}{p_Y^*} = q = \frac{q_X}{q_Y} = \frac{p_X}{(1-s_Y^P)p_Y} = \frac{1}{(1-s_Y^P)}\frac{p_X}{p_Y} = \frac{1}{(1-s_Y^P)}p > p$$

*In the figure below, therefore, the equilibrium with the production subsidy, Q', is
shown with the slope of the PPF, p', less than the given world price, p*.*

*The consumption subsidy, s_Y^C, in contrast, leaves producers facing world prices, but
reimburses consumers for a portion of what they paid for good Y: $q_Y = (1 - s_Y^C)p_Y$.
Therefore,*

$$q = \frac{q_X}{q_Y} = \frac{p_X}{(1-s_Y^C)p_Y} = \frac{1}{(1-s_Y^C)}\frac{p_X}{p_Y} = \frac{1}{(1-s_Y^C)}p > p = p^*$$

*Thus the equilibrium with the consumption subsidy, Q'', has the slope of the PPF
equaling world prices, but consumers responding to (the indifference curve tangent
to) a price line that is steeper than the world price, q''>p*.*

*From the diagrams, we see that the output of Y rises with the production subsidy, but
not with the consumption subsidy.*

*The effects on output and trade can be read from these PPF diagrams. The effects
on factor prices, however, cannot. These depend on the prices that producers face*

*and can be inferred, in nominal terms, from the Lerner diagram, with real effects
also taking account of what has happened to consumer prices.*

*From the diagrams, we see that the output of Y rises with the production subsidy, but
not with the consumption subsidy. Imports of Y rise with the consumption subsidy,
since consumption rises while production remains unchanged. Imports of Y decline
with the production subsidy, since more is produced and less is consumed (due to the
drop in income, assuming Y is a normal good).*
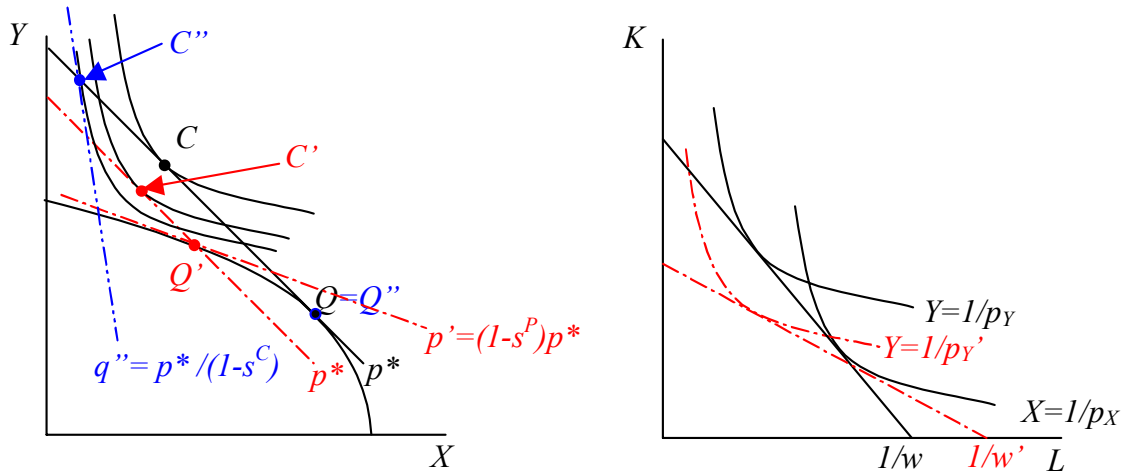
*As for the wage of labor, the production subsidy raises the price received by Y
producers, pulling the unit-value isoquant inward (assuming that we use X as
numeraire). Since Y is capital intensive, this lowers the nominal wage. As
consumers, workers face the same prices as before, so this is a drop in their real
wage. When we use a consumption subsidy for Y instead, this leaves producer prices
unchanged at their world levels and therefore has no effect on nominal factor prices.
As consumers, however, the workers enjoy a lower subsidized price of Y, so their
real wage rises.*

*(Note that the same is true of the real rental price of capital, so both real factor
prices go up! This is possible, even though aggregate welfare declines, because we
have not accounted for the financing of the subsidy. Our assumption is that the
subsidy is financed through nondistorting lump-sum taxes, which lower the income
of somebody, perhaps everybody, at the same time that they are enjoying higher real
factor prices. Depending on who pays these taxes, somebody is surely worse off, and
perhaps everybody.)*

4. The United States taxes consumption of cigarettes, which it exports. Use either the
    Heckscher-Ohlin or the (Standard) Specific Factors model with free trade to answer
    the following:
    a. Assuming (unrealistically) that there are no other distortions at home or abroad,
        how does this tax affect the consumption of cigarettes and the welfare of
   consumers in the US *and* abroad?
        *We don't need to look behind the scenes of the PPF for this problem, since we
        are not asked about effects on factors. Both the HO model and the Specific
        Factors model have smoothly curved PPFs, so that's what we use, together with
        a world excess supply and demand diagram to determine world prices.*

        Holding the world price constant for the moment at p_1, the consumption tax on
        cigarettes raises their price to consumers and causes them to substitute toward
        ther other good, Y, in their consumption, moving the consumption point from C
        to C'. This increases the Home (US) country's excess supply of cigarettes,
        shifting its excess demand curve to the left. This causes the world relative price
        of cigarettes to fall, from p_1* to p_2*.*
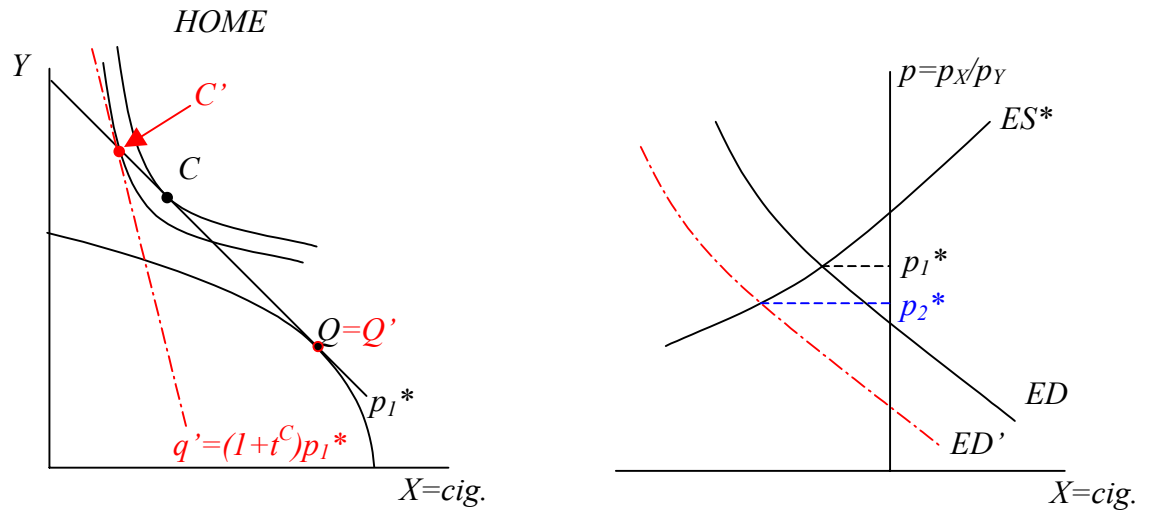

        *In the US, this price change causes further adjustments of now both production
        and consumption, reducing output of cigarettes but having an ambiguous effect
        on consumption. As drawn below, consumption of cigarettes remains below its
        initial level, but it doesn't have to. There is a loss of income, because the US was
        an exporter of the good and this drop in price is a worsening of its terms of
        trade, and this tends to reduce cigarette consumption. But the fall in their price
        on the world market stimulates cigarette consumption in the US, and could
        conceivably raise it above its initial level.*

        *What happens to US welfare? As measured by the indifference curves, it
        certainly falls, both due to the distorting effects of the tax itself and due to the*

HOME
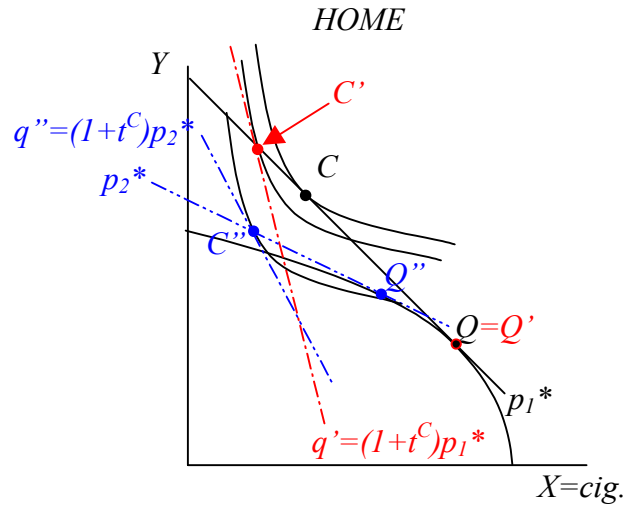
loss in income from the worsened terms of trade. Of course, the indifference curves do not take into account the effects of the cigarettes on health, which we'll discuss below.

This drop in price also affects producers and consumers abroad, where cigarettes are imported. We need a separate diagram for that, shown below. The drop in price is an improvement in Foreign's terms of trade, and both income and substitution effects increase their consumption of cigarettes. Thus their consumption of cigarettes increases, and so does their welfare as indicated by the indifference curves. Again, this ignores, so far, any effects on the health of the smokers.

FOREIGN
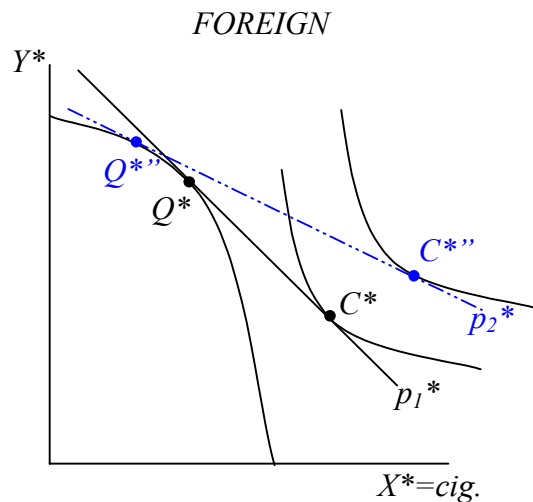
b. Without doing a formal analysis, sketch how you think your answer to part (a) would change if instead the tax were motivated by a negative consumption externality – that smoking cigarettes inflicts a cost on society – and the consumption tax was set equal to that?

This would say that the true welfare of society is not reflected in the indifference curves of consumers that determine their consumption, since as individuals they do not take into account the costs to society. Therefore anything that reduces cigarette consumption will have an additional positive effect on welfare not reflected in the indifference curves. In the analysis above, if the world price had not changed, then we could be confident that the consumption tax raised US welfare, since it would cause consumers to take this social cost into account. However, when the world price falls, this may increase US consumption, and the conclusion is no longer clear. This is because the tax, in addition to internalizing the externality, has also caused a worsening of the terms of trade that makes the country worse off. We can't be sure anymore that welfare is increased by the tax.

The welfare gain abroad is also lessened, and quite possibly reversed, if smoking has an adverse external effect there as well. Foreign consumption of cigarettes certainly increases, as we saw, and so the negative externality there is larger. Now they gain, at the same time, from a terms of trade effect, so I don't think we can be sure that they are worse off, but they could well be.

Of course, the correct solution, if there is such a negative externality in both countries, would be to tax consumption in both. The US might still be worse off, because it has been prospering by exporting harmful cigarettes to the world, and now the tax on consumers abroad would make that harder to do.