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The gains from trade

These notes explain the simplest model for calculating the gains from trade. I use a partial equilibrium model, i.e. a model in which all prices and income are held fixed, except for the price of the particular commodity that we are interested in. In contrast, a general equilibrium model takes into account the prices of inputs, such as labor and raw materials, and the prices of complements and substitutes.

First I review the meaning of consumer and producer surplus, two welfare measures that are needed to calculate the gains from trade. Then I explain the measurement of the welfare increase when a country moves from autarky (no trade) to free trade. Next I show how a trade restriction, such as a tariff or export tax, or a quantity restriction affects welfare, relative to free trade.

This simple analysis yields a number of important insights. These are: (i) There are gains to trade regardless of whether the country is an importer or an exporter. (ii) Any policy change, e.g. a move from autarky to free trade, or a move from free trade to restricted trade, has distributional effects. Some agents win and others lose. (iii) A trade restriction leads to a welfare loss: the gain to the winner is less than the loss to the loser. (iv) The welfare loss is proportional to the square of the trade restriction (e.g. the tariff). Therefore, if the restriction is small (in the sense that it leaves the economy close to free trade), a further reduction in the restriction (a movement toward free trade) has a very small welfare effect. (v)The distributional effect of a trade restriction is large relative to the welfare effect. That is, the amount by which a winner gains or a loser loses is large relative to the net losses.

1 A review of Consumer, Producer and Social Surplus

In order to evaluate the benefits and gains resulting from a change in trade policy, we need a means of measuring consumer and producer welfare; these measurements have to be in the same unit. (We cannot compare apples and

oranges.) The simplest welfare measures, and the ones that I describe here, are consumer and producer surplus.

Consumer surplus: the dollar value to consumers of participating in a market. Figure 1a shows a graph of individuals' "willingness to pay" for a commodity. In this example, the individual who values the commodity most is willing to pay \$10, the second individual is willing to pay \$8, and so on. If the price happens to be \$6, the market demand is 5 units, because there are five people willing to pay at least \$6 to buy a unit. Each person who buys obtains a "surplus": the difference between what they would be willing to spend, and what they actually have to spend. When the market price is \$6, the total surplus is the lightly shaded area in Figure 1a. If for some reason the market price falls to \$4.50, one more person wants to buy, so demand rises to 6 units. The last person to buy (the "marginal consumer") obtains zero surplus, and each of the people who were previously buying (the "infra-marginal consumers") obtain more surplus. The total surplus rises by the amount of the heavily shaded area.

Figure 1b shows a smooth demand curve. (Imagine that the commodity is something like wheat, that can be infinitely divisible, rather than something like cars, that cannot be divisible.) The area of the lightly shaded area is the consumer surplus associated with a price of P_1. If the price falls to P_2 consumer surplus rises by the area of the heavily shaded area.

Producer surplus: the difference between revenue and variable costs. (Total costs are equal to the sum of variable costs and "fixed costs". For example fixed costs equal the cost of constructing a factory; for some range of output, this cost does not depend on the number of units produced. Variable costs include costs of material and labor; these costs typically increase as production increases.) Figure 2a shows a graph of marginal costs, defined as the cost of producing each additional unit. In this example, the first unit costs \$1 to produce, the second unit costs and additional \$2, the next two units costs and additional \$2.75 each, and so on. If the price happens to be \$3.50, the firm is willing to produce 5 units. (If it produced less than 5 units, it could produce one more unit and make \$3.50 in additional revenue – more than its increased costs. If it produced more than 5 units it could increase profits by producing one fewer unit. Therefore, it is optimal for the firm to produce 5 units.

When the price is \$3.50 and the firm sells 5 units, its revenue is $\$3.50 \times 5$ and its variable costs equal the area under the marginal cost curve. The difference between revenue and variable costs is the lightly shaded area – the

producer surplus. If for some reason the price rises to \$5.50, the firm is willing to increase supply to 7 units. The *increase* in producer surplus is the heavily shaded area.

Figure 2b shows a smooth marginal cost curve, instead of a step function. (Again, think of wheat rather than cars.) If the price happens to be P_1 the producer surplus is the lightly shaded area. If the price happens to rise to P_2, the *increase* in producer surplus is the heavily shaded area.

2 The Gains from Trade

The word "autarchy" means "self-sufficient". An *autarchic equilibrium* is the equilibrium in the absence of trade. Figure 3 shows a supply and demand curve on the same graph. The two curves intersect at the price P^A (A for "autarchy"). At this price, consumers demand Q_A and producers want to supply this amount, so P^A is the equilibrium price. The consumer and producer surpluses associated with this price are shown in the figure. The sum of these is referred to as "social surplus".

Gains from trade equal the *change* in social surplus that results from trade. Suppose that the country opens up to trade, and can import at the world price $P^W < P^A$. With free trade, the domestic price falls to the world price. The *loss* in producer surplus is a measure of how much producers lose; this is the area A in Figure 4. The *increase* in consumer surplus is the amount that consumers gain. This is the area $A + B$. The change in social surplus (i.e., total surplus) is $A + B - A = B$. The area B is the gains from trade. This area is positive.

Notice that the area B is small relative to both A and to $A + B$. This fact means that the social welfare gain, also called the "efficiency gain" of a policy change (B) is small relative to the consumer gain and relative to the producer loss. In this example, the policy change is a movement from autarchy to free trade. The distributional effects of a policy typically are much greater than the efficiency effects. ("Triangles are small relative to rectangles.)

3 The Welfare Effect of a Trade Restriction

Deadweight loss from a tariff. Now I consider a different policy change – the imposition of a tariff, beginning with free trade. Figure 5 shows the welfare effect of an import tax of t for a small country that is able to import at world price p^w.[1] By moving from autarchy to free trade, domestic price falls from p^a to p^w. Consumer surplus rises and producer surplus falls, leading to the gains from trade discussed in the previous section. Suppose now that the country begins in the free trade equilibrium and then imposes an import tax (a tariff) of t. This tax causes domestic price to rise from p^w to $p^w + t$, causing consumption to fall and domestic production to increase, leading to a fall in imports from $Q^d - Q^s$ to $Q^{d'} - Q^{s'}$. The reduction in consumer surplus is the area $A + B + C + D$ and the increase in producer surplus is A. In addition there are tariff revenues of the amount $t\left(Q^{d'} - Q^{s'}\right) = C$, which is a benefit to society. (Presumably the tariff revenues are used for something useful to society.) Thus, the consumer loss minus the benefits to producers and the treasury is

$$A + B + C + D - A - C = B + D.$$

The area $B + D$ represents the deadweight cost of the import tax.

The areas B and D (or their sum) are called welfare triangles. (In this example they are literally triangles, because I drew the demand and supply curves as straight lines. For more general supply and demand curves they would only be "approximately triangles".) Using the formula for the area of a triangle ($\frac{1}{2}$x base x height), you can see that each triangle is proportional to the *square* of the tariff, t[2]

Relation between tariffs and import quotas. Notice that if the country imposes an import quota of $M \equiv Q^{d'} - Q^{s'}$, the equilibrium domestic price

[1] A "small country" is a country that is unable to affect the world price of a commodity. A "large country", in contrast, is able to alter the world price of a commodity, e.g. by means of a tariff. The analysis of the welfare effect of a tariff for a large country is a bit more complicated, because in that case we need to take into account the effect of a tariff on the world price. Since a tariff reduces domestic demand, a tariff imposed by a large country will reduce the world price of the imported commodity. This reduction in price benefits the large importing country. We need to take into account this benefit resulting from the lower import price, in addition to the changes in consumer and producer welfare that arise when even a small country uses a tariff.

[2] Consider, for example, the triangle labelled "B". Suppose that the slope of supply curve is s. The height of the triangle is the tariff, t. Denote the base of the triangle as b. Using the "rise over run" formula for a slope, we have $s = t/b$, or $b = t/s$. The area

is equal to $p^w + t$,. exactly as under the tariff of t. To convince yourself of this fact, suppose that the country imports the quantity M, the amount of the quota. In this case, total domestic supply is equal to M plus domestic production; domestic production is given by the domestic supply curve S. If you add the domestic production curve S to a vertical import supply curve at M, you obtain the total domestic supply. The intersection of this "total supply" curve and the demand curve occurs at the price $P^w + t$.

Consumers and producer welfare under the tariff and under the quota are exactly the same. Under the quota, there are no tariff revenues. However, the quota rights are valuable. The value of the right to import a unit of the commodity equals the price at which the commodity can be sold on the domestic market (which we noted equals $p^w + t$), minus the cost of purchasing it on the world market, p^w. Thus, the value of one quota licence is t, and the value of $M \equiv Q^{d'} - Q^{s'}$ quota licences is $tM = C$, the amount that we previously saw equals the tariff revenue under the tariff t. The value of quota licences is exactly equal to the value of tariff revenue.

If the government sells quota rights it obtains T dollars from the sale. In this case, welfare under a quota M is exactly the same as welfare under a tariff t. If the government gives the quota rights to citizens, this is merely a transfer of income: the loss to the domestic treasury is equal to the gain to a citizen. Thus, selling quota rights (to anyone) or giving them to citizens leads to a different distribution of domestic welfare, but the same total level of welfare.

If the government gives away quota rights to non-citizens, the value of these gifts is lost to domestic society. To the extent that quota rights are given rather than sold to non-citizens, there is an additional loss to domestic society. If all of the quota rights are given to non-citizens, the domestic welfare cost of the policy is $C + B + D$. This value is much larger than $B + D$. A gift of quota rights to non-citizens represents a transfer of rents from domestic society.

Deadweight loss from an export tax. For completeness, consider the case where a country is an exporter, and uses an export tax. Figure 6 shows a

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of a triangle is one half base times height, or

$$area = \frac{1}{2} t \left(\frac{t}{s} \right) = \frac{t^2}{2s}.$$

This equation shows that the area of triangle B is proportional to t^2.

situation where the autarkic price is p^a which is less than the world price, p^w. If the country opens up to trade, the domestic price is equal to the world price and the country exports the quantity $X = Q^s - Q^d$. If it imposes an export tax of t, the domestic price falls to $p^w - t$, and exports fall to $X' = Q^{s'} - Q^{d'}$. The gain in consumer surplus is the area A, and the loss in producer surplus is the area $A + B + C + D$. The tax revenue is tX', which equals the box C. The loss (reduced producer surplus) minus the gain (increased consumer surplus and higher tax revenue) resulting from the policy is $A + B + C + D - A - C = B + D$. This area is the deadweight loss of the export tax.