10

Export Policies in Resource and High-Technology Industries

The Middle East has its oil, China has rare earth.
Deng Xiaoping, architect of China's economic reforms, Southern Tour of China, 1992

After more than a decade, the Doha round of global trade talks finally produced a deal. The package agreed to in Bali on Saturday [December 7, 2013] is significantly less ambitious than what the representatives who convened in [Doha,] Qatar in 2001 had in mind . . . With developing and rich countries at loggerheads over sensitive topics such as agricultural duties, the World Trade Organization built around a package of "trade facilitation" measures that could be more easily agreed upon.
Financial Times, editorial, December 9, 2013, p.10.

On July 21, 2008, representatives of the 152 countries belonging to the World Trade Organization (WTO) met in Geneva, Switzerland, to discuss reforms of the world trading system. Like earlier meetings in Seattle (1999), Cancún, Mexico (2003), and Hong Kong (2005), this meeting was marked by large-scale protests. Groups including farmers from South Korea and fishermen from the Philippines objected to the impact that agricultural reforms could have on lowering food prices, thereby threatening their livelihoods. Farmers in South Korea, along with those in Japan, Europe, and the United States, benefit from an intricate system of tariffs (taxes on imports) and subsidies (payments to exporters) that keeps prices for their crops high but in some cases lowers prices in the rest of the world. The lower world price hurts farmers in land-rich developing countries such as Brazil, India, China, and some African nations by making it harder for them to export their own agricultural products. On the other hand, the lower world prices are a benefit to land-poor developing countries that must import agricultural products. Consumers in those countries will be hurt if prices end up rising as a result of agricultural reforms in the WTO.

The first goal of this chapter is to explain subsidy policies that affect resource-based industries (such as agriculture, mining, and fuel production) and high-tech industries.

Police fight rioters outside the World Trade Organization's meeting. Most of the protesters were South Korean farmers worried about rice imports.

The primary reason that countries subsidize exports is political, but there are other reasons as well. For example, agricultural subsidies benefit a group in society (such as farmers) that the government wants to support. Such subsidies occur in the United States, Europe, Japan, South Korea, and many other countries. Because these subsidies are costly to the governments of these countries and because they harm exporters from land-rich developing countries, many countries attending the Doha Round of WTO negotiations (2001–present) advocated for the removal of agricultural subsidies. In exchange for the removal of subsidies, it was expected that land-poor developing countries would lower their tariffs on agricultural goods. This complex negotiation (which involved agriculture in many countries) ultimately failed, and the 2008 Geneva meeting of the Doha Round broke up without agreement. More recently, in December 2013 a much smaller deal to streamline customs procedures was agreed to in Bali, Indonesia, but without agreement on agricultural subsidies, as indicated in the quote at the beginning of the chapter.[1] In this chapter, we describe the tentative agreements to reduce agricultural subsidies made at the 2005 Hong Kong meeting of the WTO, and the issues that could not be resolved which led to the breakup of the 2008 Geneva meeting.

Export subsidies are not the only kind of policy that is used to influence trade in resource-based industries such as agriculture, mining, and fuel extraction. The second goal of this chapter is to explain the effect of two policies, export tariffs and export quotas, on the countries that use them. To raise government revenue, some countries impose export tariffs, taxes applied by the exporting country when a good leaves the country.[2] Argentina, for example, charges export tariffs on many agricultural and resource exports. In 2011 the tariffs were 35% on soybeans, 30% on sunflower meal and oil, 23% on wheat, 20% on corn, and 20% on biodiesel (vegetable oil–based diesel fuel). Another trade policy that can sometimes benefit companies is an export quota, a restriction on the amount that producers are allowed to export. China, for example, applied quotas on firms exporting "rare earth" minerals in 2011 and 2012, which led to a substantial increase in the price of these minerals.

The third goal of the chapter is to examine how governments can strategically use export subsidies to bolster domestic companies and industries. Instead of being used to support a particular industry or to raise revenue for the government, some subsidies are meant to give a domestic industry a strategic advantage in international competition. Some high-technology industries, such as Airbus in Europe and Boeing in the United States, receive generous government subsidies, which often leads to political friction. Legislators often believe that subsidies to high-tech industries will raise those industries' profits and benefit the exporting country.

In this chapter, we assess the arguments for and against the various export policies by examining their effects on prices, the amount of trade, and welfare.

[1] "Trade facilitation" measures, referred to in the quote, mean the streamlining of customs procedures so as to increase the flow of international trade.
[2] In the United States, export tariffs are prohibited by Clause 5 of the U.S. Constitution.

1 WTO Goals on Agricultural Export Subsidies

In Table 10-1, we describe the agreements made at the Hong Kong meeting of the WTO in December 2005. These agreements were never ratified by the legislatures in the countries involved, however, so it is best to think of them as goals that have not yet been achieved rather than definite outcomes. Four of the items deal with agricultural subsidies and tariffs, which were the focus of that meeting.

Agricultural Export Subsidies

An **export subsidy** is payment to firms for every unit exported (either a fixed amount or a fraction of the sales price). Governments give subsidies to encourage domestic

TABLE 10-1

Agreements Made at the Hong Kong WTO Meeting, December 2005 This table shows the agreements made at the 2005 WTO meeting in Hong Kong, which had as its major focus the subsidies provided to agricultural products. This meeting was part of the Doha Round of WTO negotiations, which have not yet been concluded.

Issue	Decision Made in Hong Kong	Unresolved in Hong Kong
Agricultural export subsidies	Abolition by end of 2013, with a "substantial part" scrapped before 2011, and parallel elimination of indirect subsidies.	Must agree [on] value of indirect subsidies and detailed phase-out programs.
Domestic farm supports	Agreement to classify WTO members in three bands based on their level of domestic farm support (top—European Union, middle—United States and Japan, bottom—everyone else).	Must agree [on] size of subsidy reduction and rules to stop countries from shifting trade-distorting subsidies into categories sheltered from deep cuts.
Agricultural tariffs	Agreement on four tiers (different for rich and poor countries) and on a mechanism allowing poor nations to raise duties to counter import surges.	Must decide size of tariff cuts and number and treatment of "sensitive" and "special" products.
Cotton Agreement	Agreement to eliminate export subsidies in 2006 and grant unrestricted access for cotton exports from West African producers and other least developed countries (LDCs).	United States will have the "objective" of cutting its $4 billion subsidies to cotton growers further and faster than the still-to-be-agreed-upon overall reduction for domestic farm supports.
Industrial goods	Agreement on formula and on a "comparably high level of ambition" for tariff cuts in agriculture and industrial goods so rich nations do not demand more cuts than they give.	Must agree [on] key elements of formula, how much to cut, flexibilities for developing countries, and role of sectoral negotiations.
Services	Some negotiating guidelines for trade in services agreed upon . . .	The European Union is pressing for liberalization timing targets opposed by developing countries; poor nations want rich ones to accept more temporary service workers.
Development	Duty-free, quota-free access extended to 97% of product[s] . . . from least developed countries by 2008, allowing significant exclusions (e.g., U.S. textiles imports). More pledges of aid for trade.	Must agree [on] other measures to strengthen special treatment provisions for poor countries.

Source: Guy de Jonquières, "Tentative Steps Forward Seen as Better Than None at All," Financial Times, *December 19, 2005, p. 2.*

firms to produce more in particular industries. As shown in Table 10-1, the member countries of the WTO agreed to abolish all export subsidies in agriculture by the end of 2013, though as mentioned above, this goal has not yet been achieved. Some agricultural exporters, such as Brazil, India, and China, had pushed for an earlier end to the subsidies but faced stiff opposition from many European countries. Europe maintains a system of agricultural subsidies known as the **Common Agricultural Policy (CAP).** For example, to help its sugar growers, the CAP pays farmers up to 50 euros per ton of harvested sugar beets, which is five times the world market price. Because of the subsidy, European farmers can afford to sell the sugar made from their sugar beets at a much lower price than the world market price. As a result, the sugar beet subsidy makes Europe a leading supplier of sugar worldwide, even though countries in more temperate or tropical climates have a natural comparative advantage. Other countries maintain agricultural subsidies that are just as generous. The United States, for example, pays cotton farmers to grow more cotton and then subsidizes agribusiness and manufacturers to buy the American cotton, so both the production *and* the sale of cotton receive subsidies. Japan allows 10% of the approximately 7 million tons of milled rice it consumes annually to enter into the country tariff-free but imposes a 500% tariff on any rice in excess of this 10% limit. There are many other examples of agricultural protection like this from countries all over the world.

Indirect Subsidies Included in the Hong Kong export subsidy agreement is the parallel elimination of **indirect subsidies** to agriculture, including food aid from developed to poor countries and other exports by state-sponsored trading companies in advanced countries. Europe has already eliminated its food aid subsidies and argues that *cash aid* to poor countries is much more effective; the United States continues to export agricultural commodities as aid. Later in the chapter, we explore the argument made by the European Union that cash aid is more effective than food aid in assisting developing countries.

Domestic Farm Supports Another item mentioned in the Hong Kong agreement is **domestic farm supports,** which refers to any assistance given to farmers, even if it is not directly tied to exports. Such domestic assistance programs can still have an indirect effect on exports by lowering the costs (and hence augmenting the competitiveness) of domestic products. The Hong Kong agreement is only a first step toward classifying the extent of such programs in each country, without any firm commitment as to when they might be eliminated.

Cotton Subsidies Finally, export subsidies in cotton received special attention because that crop is exported by many low-income African countries and is highly subsidized in the United States. The United States agreed to eliminate these export subsidies, but that action has not yet occurred because the Hong Kong agreement was never ratified. Subsidies to the cotton industry remain a contentious issue between the United States and other exporting countries, such as Brazil.

Other Matters from the Hong Kong WTO Meeting

Issues that are related to export subsidies were also discussed at the 2005 Hong Kong meeting, in addition to the elimination of the subsidies themselves. One of these issues is the use of tariffs as a response to other countries' use of subsidies. As we now explain, that issue is so contentious that it led to the breakup of the subsequent meeting in Geneva in 2008 and threatens to derail the Doha Round of negotiations.

Tariffs in Agriculture Export subsidies applied by large countries depress world prices, so that exporting countries can expect tariffs to be imposed on the subsidized products when they are imported by other countries. The agriculture-exporting developing countries pushed for a dramatic reduction in these and other agriculture-related tariffs, especially by importing industrial countries, but were not able to obtain such a commitment in Hong Kong.

These discussions continued three years later in Geneva. At that time, the developing country food importers wanted two special provisions allowing them to limit the amount by which tariffs would be lowered. First, they wanted a list of "special products" that would be completely exempt from tariff reductions. Second, they wanted a "special safeguard mechanism" that could be applied to all other agricultural products. Under this mechanism, tariffs could be temporarily raised whenever imports suddenly rose or their prices suddenly fell.

Recall from Chapter 8 that Article XIX of the GATT allows for such a "safeguard tariff," and that there are specific rules allowing for its use mainly in manufactured goods (see **Side Bar: Key Provisions of the GATT** in Chapter 8). The "special safeguard mechanism" in agriculture likewise requires that countries agree on the exact conditions under which it would be used. The problem in Hong Kong was that countries could not agree on the conditions under which a safeguard tariff could be temporarily applied. Likewise, the negotiators at the Geneva meeting could not agree on how many agricultural products could be treated as "special" by the importing countries, and exempt from any tariff cuts. These conflicts led to the breakdown of the Geneva talks in 2008, but must eventually be resolved before the Doha Round of negotiations can be concluded.

Issues Involving Trade in Industrial Goods and Services Other issues were also discussed in Hong Kong, as listed in Table 10-1. To achieve further cuts in the tariffs on industrial goods, there was agreement in principle to use some formula for the cuts, but the exact nature of that formula was left for future negotiation. There was also an agreement to discuss opening trade in service sectors, which would benefit the industrial countries and their large service industries. The developing countries are expected to make some future offers to open their markets to trade in services, but in return they will expect wealthy countries to accept more temporary immigrant workers in their service sectors. Finally, there was agreement to allow 97% of imported products from the world's 50 least developed countries (LDCs) to enter WTO member markets tariff free and duty free. The United States already allows duty-free and tariff-free access for 83% of products from those 50 countries, and under this agreement, the United States would extend that access to nearly all products. Omitted from this agreement, however, are textile imports into the United States from LDCs because the United States wants to protect its domestic textile producers from low-priced imports from countries such as Bangladesh and Cambodia. This is not surprising, given our discussion of the United States' sensitivity to low-cost imports in the clothing and textiles industries, as illustrated by the history of quotas on clothing imports (see Chapter 8).

2 Export Subsidies in a Small Home Country

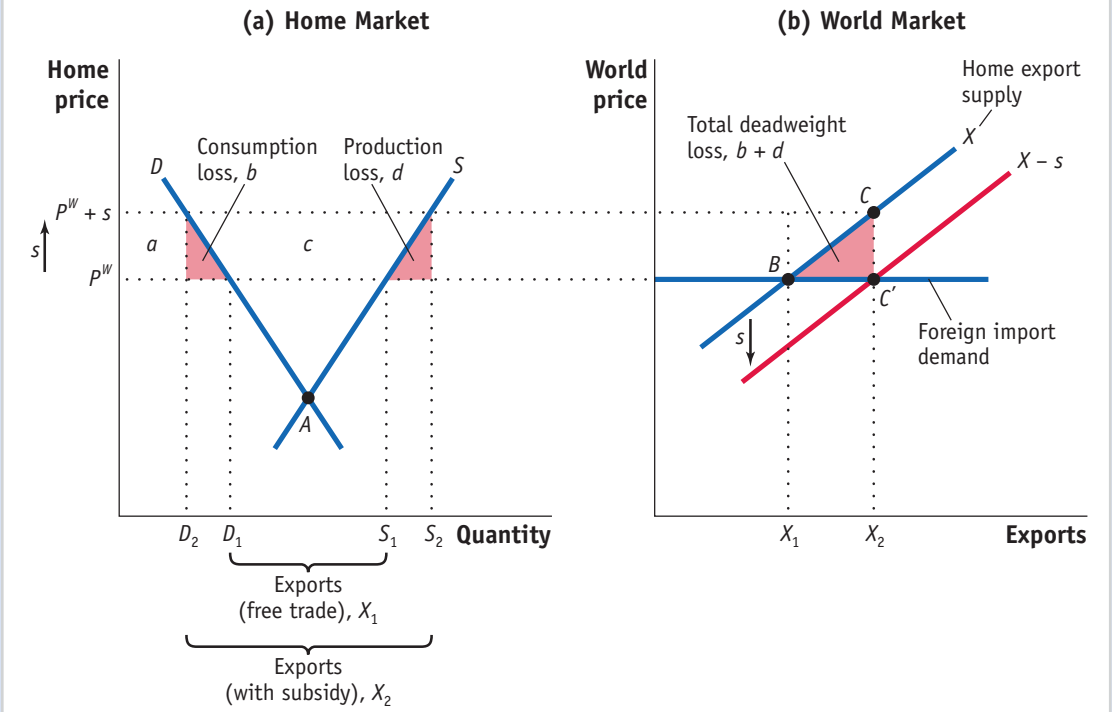
To see the effect of export subsidies on prices, exports, and welfare, we begin with a small Home country that faces a fixed world price for its exports. Following that, we see how the outcomes differ when the Home country is large enough to affect world prices.

Consider a small country exporting sugar. The Home no-trade equilibrium is at point A in Figure 10-1. With free trade, Home faces the world price of sugar P^W. In panel (a) of Figure 10-1, the quantity supplied in Home at that price is S_1 and the quantity demanded is D_1 tons of sugar. Because quantity demanded is less than quantity supplied, the Home country exports $X_1 = S_1 - D_1$ tons under free trade. That quantity of exports is shown as point B in panel (b) corresponding to the free-trade price of P^W. By determining the level of exports at other prices, we can trace out the Home export supply curve X.

Impact of an Export Subsidy

Now suppose that because the government wishes to boost the exports of the domestic sugar producers, each ton of sugar exported receives a subsidy of s dollars from the government. Panel (a) of Figure 10-1 traces the effect of this subsidy on the domestic economy. With an export subsidy of s dollars per ton, exporters will receive $P^W + s$ for

FIGURE 10-1



Export Subsidy for a Small Country Applying a subsidy of s dollars per unit exported will increase the price that Home exporters receive from P^W to $P^W + s$. As a result, the domestic price of the similar good will also rise by that amount. This price rise leads to an increase in Home quantity supplied from S_1 to S_2 and a decrease in Home quantity demanded from D_1 to D_2, in panel (a). Exports rise as a result of the subsidy, from X_1 to X_2 in panel (b). The Home export supply curve shifts down by exactly the amount of the subsidy since the marginal cost of a unit of exports decreases by exactly s. As in the case of a tariff, the deadweight loss as a result of the subsidy is the triangle ($b + d$), the sum of consumer loss b and producer loss d.

each ton exported rather than the lower free-trade price P^W. Because they are allowed to export any amount they want at the subsidized price, the Home firms will not accept a price less than $P^W + s$ for their domestic sales: if the domestic price was less than $P^W + s$, the firms would just export all their sugar at the higher price. Thus, the domestic price for sugar must rise to $P^W + s$ so that it equals the export price received by Home firms.

Notice that with the domestic sugar price rising to $P^W + s$, Home consumers could in principle *import* sugar at the price of P^W rather than buy it from local firms. To prevent imports from coming into the country, we assume that the Home government has imposed an import tariff equal to (or higher than) the amount of the export subsidy. This is a realistic assumption. Many subsidized agricultural products that are exported are also protected by an import tariff to prevent consumers from buying at lower world prices. We see that the combined effect of the export subsidy and import tariff is to raise the price paid by Home consumers and received by Home firms.

With the price rising to $P^W + s$, the quantity supplied in Home increases to S_2, while the quantity demanded falls to D_2 in panel (a). Therefore, Home exports increase to $X_2 = S_2 - D_2$. The change in the quantity of exports can be thought of in two ways as reflected by points C and C' in panel (b). On one hand, if we were to measure the *Home price* P^W on the vertical axis, point C is on the original Home export supply curve X: that is, the rise in Home price has resulted in a *movement along* Home's initial supply curve from point B to C since the quantity of exports has increased with the Home price.

On the other hand, with the vertical axis of panel (b) measuring the *world price* and given our small-country assumption that the world price is fixed at P^W, the increase in exports from X_1 to X_2 because of the subsidy can be interpreted as a *shift* of the domestic export supply curve to $X - s$, which includes point C'. Recall from Chapter 8 that the export supply curve shifts by precisely the amount of the tariff. Here, because the export subsidy is like a negative tariff, the Home export supply curve shifts down by exactly the amount s. In other words, the subsidy allows firms to sell their goods to the world market at a price exactly s dollars lower *at any point* on the export supply curve; thus, the export supply curve shifts down. According to our small-country assumption, Home is a price taker in the world market and thus always sells abroad at the world price P^W; the only difference is that with the subsidy, Home exports higher quantities.

Summary From the domestic perspective, the export subsidy increases both the price and quantity of exports, a movement along the domestic export supply curve. From the world perspective, the export subsidy results in an increase in export supply and, given an unchanged world price (because of the small-country assumption), the export supply curve shifts down by the amount of the subsidy s. As was the case with a tariff, the subsidy has driven a wedge between what domestic exporters receive ($P^W + s$ at point C) and what importers abroad pay (P^W at point C').

Impact of the Subsidy on Home Welfare Our next step is to determine the impact of the subsidy on the welfare of the exporting country. The rise in Home price lowers consumer surplus by the amount $(a + b)$ in panel (a). That is the area between the two prices (P^W and $P^W + s$) and underneath the demand curve D. On the other hand, the price increase raises producer surplus by the amount $(a + b + c)$, the area between the two prices (P^W and $P^W + s$), and above the supply curve S. Finally, we

need to determine the effect on government revenue. The export subsidy costs the government s per unit exported, or $s \cdot X_2$ in total. That revenue cost is shown by the area $(b + c + d)$.

Adding up the impact on consumers, producers, and government revenue, the overall impact of the export subsidy is

Fall in consumer surplus:	$-(a + b)$
Rise in producer surplus:	$+(a + b + c)$
Fall in government revenue:	$-(b + c + d)$
Net effect on Home welfare:	$\mathbf{-(b + d)}$

The triangle $(b + d)$ in panel (b) is the net loss or **deadweight loss** due to the subsidy in a small country. The result that an export subsidy leads to a deadweight loss for the exporter is similar to the result that a tariff leads to a deadweight loss for an importing country. As with a tariff, the areas b and d can be given precise interpretations. The triangle d equals the increase in marginal costs for the extra units produced because of the subsidy and can be interpreted as the **production loss** or the *efficiency loss* for the economy. The area of the triangle b can be interpreted as the drop in consumer surplus for those individuals no longer consuming the units between D_1 and D_2, which we call the **consumption loss** for the economy. The combination of the production and consumption losses is the deadweight loss for the exporting country.

3 Export Subsidies in a Large Home Country

Now suppose that the Home country is a large enough seller on international markets so that its subsidy affects the world price of the sugar (e.g., this occurs with European sugar subsidies and U.S. cotton subsidies). This large-country case is illustrated in Figure 10-2. In panel (b), we draw the Foreign import demand curve M^* as downward-sloping because changes in the amount exported, as will occur when Home applies a subsidy, now affect the world price.

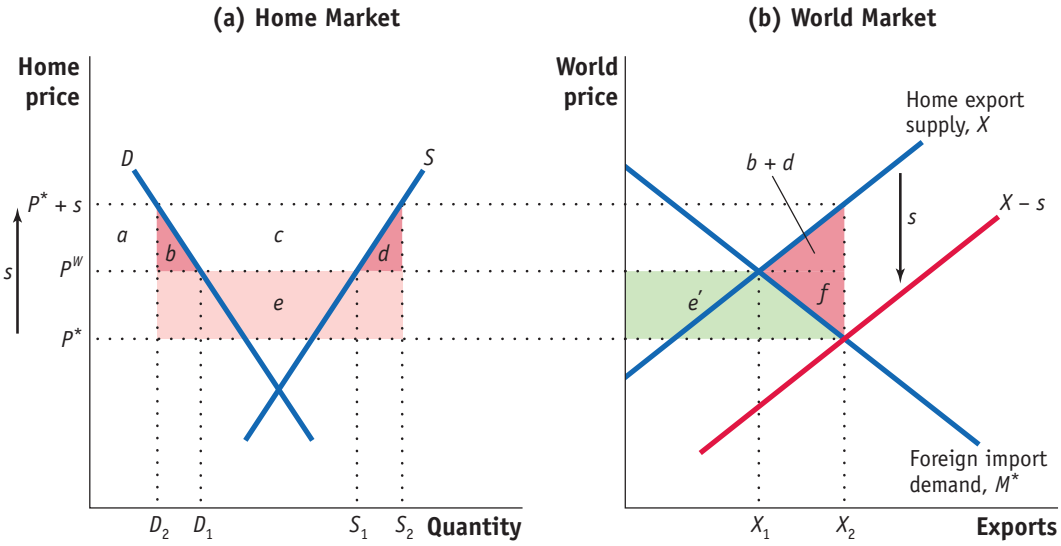
Under free trade, the Home and world price is P^W. At this price, Home exports $X_1 = S_1 - D_1$, and the world export market is in equilibrium at the intersection of Home export supply X and Foreign import demand M^*. Home and Foreign consumers pay the same price for the good, P^W, which is the world price.

Effect of the Subsidy

Suppose that Home applies a subsidy of s dollars per ton of sugar exported. As we found for the small country, a subsidy to Home export production is shown as a downward shift of the Home export supply curve in panel (b) by the amount s; the vertical distance between the original export supply curve X and the new export supply curve $X - s$ is precisely the amount of the subsidy s. The new intersection of Home export supply, $X - s$, and Foreign import demand M^* corresponds to a new world price of P^*, decreased from the free-trade world price P^W, and a Home price $P^* + s$, increased from the free-trade price P^W. Furthermore, the equilibrium with the subsidy now occurs at the export quantity X_2 in panel (b), increased from X_1.

In Chapter 2, we defined the *terms of trade* for a country as the ratio of export prices to import prices. Generally, a fall in the terms of trade indicates a loss for a country because it is either receiving less for exports or paying more for imports. We have

FIGURE 10-2



Export Subsidy for a Large Country Panel (a) shows the effects of the subsidy at Home. The Home price increases from P^W to $P^* + s$, Home quantity demanded decreases from D_1 to D_2, and Home quantity supplied increases from S_1 to S_2. The deadweight loss for Home is the area of triangle $(b + d)$, but Home also has a terms-of-trade loss of area e. In the world market, the Home subsidy shifts out the export supply curve from X to $X - s$ in panel (b). As in the small-country case, the export supply curve shifts down by the amount of the subsidy, reflecting the lower marginal cost of exports. As a result, the world price falls from P^W to P^*. The Foreign country gains the consumer surplus area e', so the world deadweight loss due to the subsidy is the area $(b + d + f)$. The extra deadweight loss f arises because only a portion of the Home terms-of-trade loss is a Foreign gain.

found that with the export subsidy, Foreign consumers pay a lower price for Home exports, which is therefore a fall in the Home terms of trade but a gain in the Foreign terms of trade. We should expect, therefore, that the Home country will suffer an overall loss because of the subsidy but that Foreign consumers will gain. To confirm these effects, let's investigate the impact of the subsidy on Home and Foreign welfare.

Home Welfare In panel (a) of Figure 10-2, the increase in the Home price from P^W to $P^* + s$ reduces consumer surplus by the amount $(a + b)$. In addition, the increase in the price benefits Home firms, and producer surplus rises by the amount $(a + b + c)$. We also need to take into account the cost of the subsidy. Because the amount of the subsidy is s, and the amount of Home exports (after the subsidy) is $X_2 = S_2 - D_2$, it follows that the revenue cost of the subsidy to the government is the area $(b + c + d + e)$, which equals $s \cdot X_2$ (the government pays s for every unit exported). Therefore, the overall impact of the subsidy in the large country can be summarized as follows:

Fall in consumer surplus:	$-(a + b)$
Rise in producer surplus:	$+(a + b + c)$
Fall in government revenue:	$-(b + c + d + e)$
Net effect on Home welfare:	$\mathbf{-(b + d + e)}$

In the world market, panel (b), the triangle ($b + d$) is the deadweight loss due to the subsidy, just as it is for a small country. For the large country, however, there is an extra source of loss, the area e, which is the terms-of-trade loss to Home: $e = e' + f$ in panel (b). When we analyze Foreign and world welfare, it will be useful to divide the Home terms-of-trade loss into two sections, e' and f, but from Home's perspective, the terms-of-trade welfare loss is just their sum, area e. This loss is the decrease in export revenue because the world price has fallen to P^*; Home loses the difference between P^W and P^* on each of X_2 units exported. So a large country loses even more from a subsidy than a small country because of the reduction in the world price of its exported good.

Foreign and World Welfare While Home definitely loses from the subsidy, the Foreign importing country definitely gains. Panel (b) of Figure 10-2 illustrates the consumer surplus benefit to Foreign of the Home subsidy; the price of Foreign imports decreases and Foreign's terms of trade improves. The change in consumer surplus for Foreign is area e', the area below its import demand curve M^* and between the free-trade world price P^W and the new world price (with subsidy) P^*.

When we combine the total Home consumption and production losses ($b + d$) plus the Home terms-of-trade loss e, and subtract the Foreign terms-of-trade gain e', there is an overall deadweight loss for the world, which is measured by the area ($b + d + f$) in panel (b). The area f is the additional world deadweight loss due to the subsidy, which arises because the terms-of-trade loss in Home is not completely offset by a terms-of-trade gain in Foreign.

Because there is a transfer of terms of trade from Home to Foreign, the export subsidy might seem like a good policy tool for large wealthy countries seeking to give aid to poorer countries. However, this turns out not to be the case. The deadweight loss f means that using the export subsidy to increase Home production and send the excess exported goods overseas (as was the case for food aid, discussed earlier as an example of an indirect subsidy) is an inefficient way to transfer gains from trade among countries. It would be more efficient to simply give cash aid in the amount of the Home terms-of-trade loss to poor importers, a policy approach that, because it does not change the free-trade levels of production and consumption in either country, would avoid the deadweight loss ($b + d + f$) associated with the subsidy. This argument is made by the European countries, which, several years ago, eliminated transfers of food as a form of aid and switched to cash payments. The United States has now agreed to make the same policy change, as discussed in the following application.

APPLICATION

Who Gains and Who Loses?

Now that we have studied the effect of export subsidies on world prices and trade volume in theory, we return to the agreements of the Hong Kong meeting of the WTO in December 2005 and ask: Which countries will gain and which will lose when export subsidies (including the "indirect" subsidies like food aid) are ever eliminated?

Gains The obvious gainers from this action will be current agricultural exporters in developing countries such as Brazil, Argentina, Indonesia, and Thailand, along with potential exporters such as India and China. These countries will gain from the rise in world prices as agricultural subsidies by the industrialized countries—especially

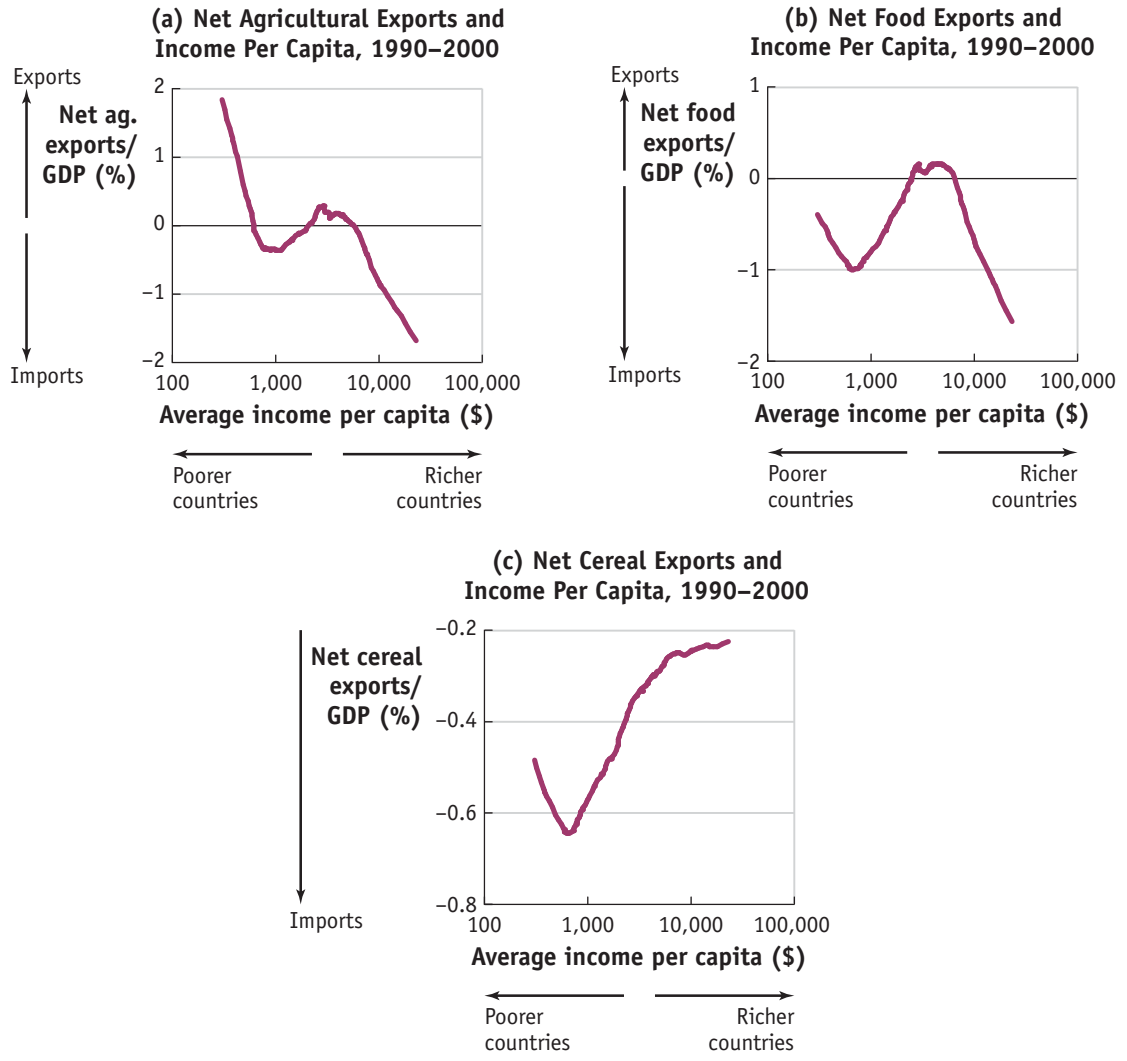
Europe and the United States—are eliminated. These countries will gain even more when and if an agreement is reached on the elimination of agricultural tariffs in the industrial countries, including Japan and South Korea, that protect crops such as rice. Both of these actions will also benefit the industrial countries themselves, which suffer both a deadweight loss *and* a terms-of-trade loss from the combination of export subsidies and import tariffs in agriculture. Farmers in the industrial countries who lose the subsidies will be worse off, and the government might choose to offset that loss with some type of adjustment assistance. In the United States and Europe, however, it is often the largest farmers who benefit the most from subsidy programs, and they may be better able to adjust to the elimination of subsidies (through switching to other crops) than small farmers.

Losses Which countries will lose from the elimination of export subsidies? To the extent that the elimination of export subsidies leads to higher world prices, as we expect from our analysis (in Figure 10-2, the price would rise from P^* to P^W), then the food-importing countries, typically the poorer non-food-producing countries, will lose. This theoretical result is confirmed by several empirical studies. One study found that the existing pattern of agricultural supports (tariffs and subsidies) raises the per capita income of two-thirds of 77 developing nations, including most of the poorest countries, such as Burundi and Zambia.[3] This result is illustrated in Figure 10-3. Panel (a) shows net agricultural exports graphed against countries' income per capita over the period 1990 to 2000. The poorer countries (i.e., those lower on the income scale on the horizontal axis) export more agricultural products and therefore would benefit from a rise in their prices. But for *food* exports in panel (b), rather than *total agricultural* exports (which includes non-food items like cotton), it is the middle-income countries that export the most. Panel (c) shows that poor countries are *net importers* of essential food items such as corn, rice, and wheat (summarized as "cereal exports") and would be harmed by an increase in their world price. Many of the world's poorest individuals depend on cereal crops for much of their diet and would be especially hard hit by any increase in those prices.

Food Aid What about indirect subsidies such as food aid? The United States has been a principal supplier of food aid, which it uses for both humanitarian purposes and to get rid of surpluses of food products at home. No country will argue with the need for donations in cases of starvation, as have occurred recently in the Darfur region of Sudan and in 1984 in Ethiopia, but the United States also provides food shipments to regions without shortages, an action that can depress local prices and harm local producers. European countries stopped this practice many years ago and argue that it is better to instead have United Nations relief agencies buy food from local farmers in poor regions and then distribute it to the poorest individuals in a country. In this way, the European countries boost production in the country and help to feed its poorest citizens. In the Hong Kong talks, the European Union insisted that the indirect subsidies to regions without shortages be eliminated.

[3] Margaret McMillan, Alix Peterson Zwane, and Nava Ashraf, 2007, "My Policies or Yours: Have OECD Agricultural Policies Affected Incomes in Developing Countries?" In Ann Harrison, *Globalization and Poverty* [Chicago: University of Chicago Press and National Bureau of Economic Research (NBER)], pp. 183–232.

FIGURE 10-3



Agriculture, Food, and Cereal Exports Panel (a) shows net agricultural exports graphed against countries' income per capita. The poorer countries export more agricultural products overall and would thus benefit from a rise in the prices due to the removal of subsidies. On the other hand, panel (b) shows that it is middle-income countries that export the most food. Panel (c) shows that poor countries are net *importers* of essential food items (cereals) such as corn, rice, and wheat and would be harmed by an increase in their world price.

Source: Margaret McMillan, Alix Peterson Zwane, and Nava Ashraf, 2007, "My Policies or Yours: Have OECD Agricultural Policies Affected Incomes in Developing Countries?" In Ann Harrison, Globalization and Poverty *(Chicago: University of Chicago Press and NBER), pp. 183–232.*

Even though the proposals from the Hong Kong talks were never ratified and the elimination of tariff and subsidies in agriculture has not occurred, the Doha Round of negotiations is still ongoing and some progress has been made toward the goal of replacing food aid with efforts to increase production. In 2009, the Group of Eight

(G8)[4] countries pledged to increase funding for agricultural development by $12 billion per year, as described in **Headlines: G8 Shifts Focus from Food Aid to Farming.** This pledge represents a shift in focus away from food aid and toward agricultural sustainability in developing countries. As the Headlines article describes, this approach is a major shift in focus for the United States, where 20 times more money has been spent on food aid than on projects to increase local production.

Despite this announcement, however, many observers remain skeptical that the funding for agricultural development in poor countries will be forthcoming. After the G8 summit many editorials appeared challenging these countries to follow through on their pledges. We include one of these editorials in **Headlines: Hunger and Food Security Back on Political Agenda;** this one written by the chairman of the European Food Security Group, a network of 40 European nongovernmental organizations. ■

HEADLINES

G8 Shifts Focus from Food Aid to Farming

This article announces a new "food security initiative" from the G8 countries, who promised billions of dollars to assist farmers in developing countries. As the next Headlines article describes, however, not all observers believe that these funds will be forthcoming, despite the overwhelming need for the assistance.

The G8 countries will this week announce a "food security initiative," committing more than $12 [billion] for agricultural development over the next three years, in a move that signals a further shift from food aid to long-term investments in farming in the developing world.

The US and Japan will provide the bulk of the funding, with $3–$4 [billion] each, with the rest coming from Europe and Canada, according to United Nations officials and Group of Eight diplomats briefed on the "L'Aquila Food Security Initiative." Officials said it would more than triple spending. . . .

The G8 initiative underscores Washington's new approach to fighting global hunger, reversing a two-decades-old policy focused almost exclusively on food aid. Hillary Clinton, US secretary of state, and Tom Vilsack, the agriculture secretary, have both highlighted the shifting emphasis in recent speeches.

"For too long, our primary response [to fight hunger] has been to send emergency [food] aid when the crisis is at its worst," Ms. Clinton said last month. "This saves lives, but it doesn't address hunger's root causes. It is, at best, a short-term fix."

Washington's shift could prove contentious in the US, as its farmers are the largest exporters of several crops, including soyabean and corn. The US is the world's largest donor of food aid—mainly crops grown by US farmers, costing more than $2 [billion] last year.

The Chicago Council on Global Affairs, a think-tank, estimates that Washington spends 20 times more on food aid than on long-term schemes in Africa to boost local food production. US annual spending on African farming projects topped $400 [million]in the 1980s, but by 2006 had dwindled to $60 [million], the council said in a report this year. . . .

[4] The G8 countries consist of Canada, France, Germany, Italy, Japan, Russia, the United Kingdom, and the United States. In addition, the European Union as a whole is represented at the G8.

HEADLINES

Hunger and Food Security Back on Political Agenda

This article expresses skepticism that the promises of the G8 countries for billions of dollars to assist farmers in developing countries will be forthcoming.

Global food security is a political and economic priority for the first time since the early 1970s. That should be the key message from the decision by the G8 group of leading economic nations to endorse a "food security initiative" at their meeting in Italy this week. But this welcome decision needs to be followed up by further significant policy change at national and international level if food security is to be achieved for the world's growing population over the coming decades. . . .

It is reported that the initiative will involve a commitment of $12 billion for agricultural development over the next three years. But before giving three cheers for the G8, two critical questions must be answered. Is the $12 billion additional resources or a repackaging of existing commitments? How can this initiative feed into sustained policy change aimed at increasing food security at household, national and global level?

Policy change is necessary in many countries which are currently food insecure. Investment in agricultural and rural development has been shamefully neglected over the past 30 years. Donors, including the World Bank, also bear responsibility for this. There must now be an acceptance that budget allocations to agriculture must increase and must be sustained. . . . The history of such summits is not good: the gap between the promises and subsequent actions is great. At the first such summit in 1974, Dr. Henry Kissinger made the pledge that "within 10 years, no child will go to bed hungry."

The G8 food security initiative at least provides a positive backdrop to the summit. It should provide an opportunity to many developing countries to commit to the type of policy change necessary to increase their own food security. With one billion hungry people in the world, with growing populations and with the threat that climate change presents to agricultural production capacity, such a commitment is both critical and urgent. It is good politics and good economics to do so.

Source: Excerpted from Tom Arnold, "Hunger and Food Security Back on Political Agenda," The Irish Times, *July 8, 2009, electronic edition.*

4 Production Subsidies

The agreements reached in Hong Kong in 2005 distinguish between export subsidies in agriculture—which will be eliminated—and all other forms of domestic support that increase production (e.g., tax incentives and other types of subsidies). The agreements make this distinction because other forms of agricultural support are expected to have less impact on exports than direct subsidies. Therefore, there is less impact on other countries from having domestic support programs as compared with export subsidies. To illustrate this idea, let's examine the impact of a "production subsidy" in agriculture for both a small and a large country.

Suppose the government provides a subsidy of s dollars for *every unit* (e.g., ton of sugar in our example) that a Home firm produces. This is a **production subsidy** because it is a subsidy to every unit produced and not just to units that are exported. There are several ways that a government can implement such a subsidy. The government might guarantee a minimum price to the farmer, for example, and make up the difference between the minimum price and any lower price for which the farmer sells.

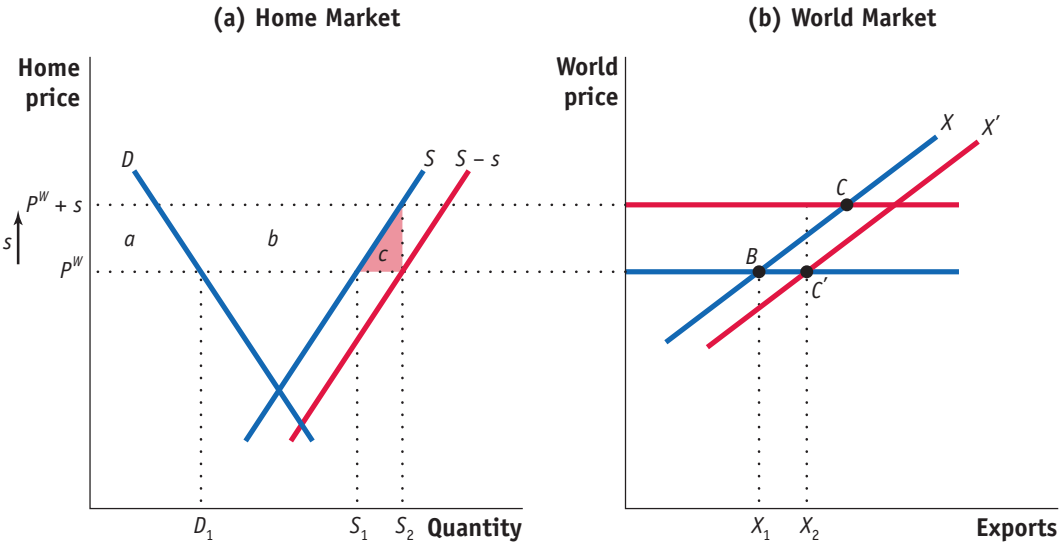
Alternatively, the government might provide subsidies to users of the crop to purchase it, thus increasing demand and raising market prices; this would act like a subsidy to every unit produced. As mentioned earlier, the United States has used both methods to support its cotton growers.

These policies all fall under Article XVI of the GATT (see **Side Bar: Key Provisions of the GATT** in Chapter 8). Article XVI states that partner countries should be notified of the extent of such subsidies, and when possible, they should be limited. In Hong Kong, the WTO members further agreed to classify countries according to the extent of such subsidies, with the European Union classified as having a high level of production subsidies, the United States and Japan having a middle level, and all other countries having low subsidies (see Table 10-1). Future discussion will determine the timing and extent of cuts in these production subsidies.

Effect of a Production Subsidy in a Small Home Country

To illustrate the effect of a production subsidy, we begin with a small country that faces a fixed world price of P^W. In Figure 10-4, panel (a), the production subsidy of s increases the price received by Home producers to $P^W + s$ and increases Home's quantity supplied from S_1 to S_2. The quantity *demanded* at Home does not change,

FIGURE 10-4



Production Subsidy for a Small Country In panel (a), applying a production subsidy of s dollars per unit produced will increase the price that Home firms receive from P^W to $P^W + s$. This price rise leads to an increase in Home quantity supplied from S_1 to S_2. The consumer price at Home is not affected because the production subsidy does not distinguish between items sold at Home or exported (firms therefore continue to charge the world price at Home), so the quantity demanded stays at D_1. The deadweight loss of the subsidy for a small country is the area c. In panel (b), exports rise as a result of the production subsidy, from X_1 to X_2, though the increase in exports is less than for the export subsidy because, for the production subsidy, quantity demanded does not change at Home.

however, because producers *continue to charge the world price* at Home. This is the case (in contrast to the export subsidy) because Home producers receive a subsidy regardless of whom they sell to (domestic consumers or Foreign consumers through exporting). So with a production subsidy, Home producers charge the world price to Foreign consumers and receive the extra subsidy from the government and likewise charge the world price to Home consumers, and again receive the extra subsidy. In contrast, for an export subsidy, Home firms receive the subsidy *only* for export sales and not for domestic sales.

Because the price for Home consumers with the production subsidy is still P^W, there is no change in the quantity demanded at Home, which remains at D_1. In panel (b), we see that the production subsidy increases the quantity of exports from $X_1 = S_1 - D_1$ to $X_2 = S_2 - D_1$. Because demand is not affected, the production subsidy increases exports by less than an export subsidy would. That result occurs because the quantity demanded decreases with an export subsidy due to higher Home prices, leading to greater Home exports. In contrast, with the production subsidy, the quantity demanded at Home is unchanged, so exports do not rise as much.

Home Welfare With the increase in the price received by Home producers, from P_W to $P_W + s$, there is a corresponding rise in producer surplus of the amount $(a + b)$ in panel (a). The government revenue cost of the subsidy is the entire area $(a + b + c)$, which equals the amount of the subsidy s, times Home production S_2. So the overall impact of the production subsidy is

Change in consumer surplus:	*none* (because demand is not affected)
Rise in producer surplus:	$+ (a + b)$
Fall in government revenue:	$- (a + b + c)$
Net effect on Home welfare:	$\boldsymbol{- c}$

The deadweight loss caused by the production subsidy in a small country, area c, is less than that caused by the export subsidy in Figure 10-1, which is area $(b + d)$. The reason that the production subsidy has a lower deadweight loss than the export subsidy is that consumer decisions have not been affected at all: Home consumers still face the price of P^W. The production subsidy increases the quantity supplied by Home producers, just as an export subsidy does, but the production subsidy does so without raising the price for Home consumers. The only deadweight loss is in production inefficiency: the higher subsidized price encourages Home producers to increase the amount of production at higher marginal costs (i.e., farther right along the supply curve) than would occur in a market equilibrium without the subsidy.

Targeting Principle Our finding that the deadweight loss is lower for the production subsidy makes it a better policy instrument than the export subsidy to achieve an increase in Home supply. This finding is an example of the **targeting principle:** *to achieve some objective, it is best to use the policy instrument that achieves the objective most directly.* If the objective of the Home government is to increase cotton supply, for example, and therefore benefit cotton growers, it is better to use a production subsidy than an export subsidy. Of course, the benefits to cotton growers come at the expense of government revenue.

There are many examples of this targeting principle in economics. To limit the consumption of cigarettes and improve public health, the best policy is a tax on cigarette purchases, as many countries use. To reduce pollution from automobiles, the best policy

would be a tax on gasoline, the magnitude of which is much higher in Europe than in the United States. And, to use an example from this book, to compensate people for losses from international trade, it is better to provide trade adjustment assistance directly (discussed in Chapter 3) to those affected than to impose an import tariff or quota.

Effect of the Production Subsidy in a Large Home Country

We will not draw the large-country case in detail but will use Figure 10-4 to briefly explain the effects of a production subsidy on prices, exports, and welfare. When the price for Home producers rises from P^W to $P^W + s$, the quantity of the exported good supplied increases from S_1 to S_2. Because demand has not changed, exports increase by exactly the same amount as the quantity supplied by domestic producers. We show that increase in exports by the outward shift of the export supply curve, from X to X' in panel (b). As mentioned previously, the rise in the quantity of exports due to the production subsidy, from point B to C' in Figure 10-4, is *less than* the increase in the quantity of exports for the export subsidy, from point B to C' shown in Figure 10-1. With the export subsidy, the price for Home producers *and* consumers rose to $P^W + s$, so exports increased because of both the rise in quantity supplied and the drop in quantity demanded. As a result, the export subsidy shifted down the Home export supply curve by exactly the amount s in Figure 10-1. In contrast, with a production subsidy, exports rise only because Home quantity supplied increases so that export supply shifts down by an amount less than s in Figure 10-4.

If we drew a downward-sloping Foreign import demand curve in panel (b), then the increase in supply as a result of the production subsidy would lower the world price. But that drop in world price would be *less than* the drop that occurred with the export subsidy because the increase in exports under the production subsidy is less.

Summary Production subsidies in agriculture still lower world prices, but they lower prices by less than export subsidies. For this reason, the WTO is less concerned with eliminating production subsidies and other forms of domestic support for agriculture. These policies have a smaller impact on world prices and, as we have also shown, a smaller deadweight loss as compared with that of export subsidies.

5 Export Tariffs

Export and production subsidies are not the only policies that countries use to influence trade in certain products. Some countries apply **export tariffs**—which are taxes applied by the exporting country when a good leaves the country. As we saw in the introduction to this chapter, Argentina applies export tariffs on many of its agricultural products. Mozambique charges a tariff on exports of diamonds, and Thailand charges a tariff on exports of teak wood. The main purpose of these export tariffs is to raise revenue for the government; farmers and other companies do not benefit from the export tariffs, because they pay the tax.

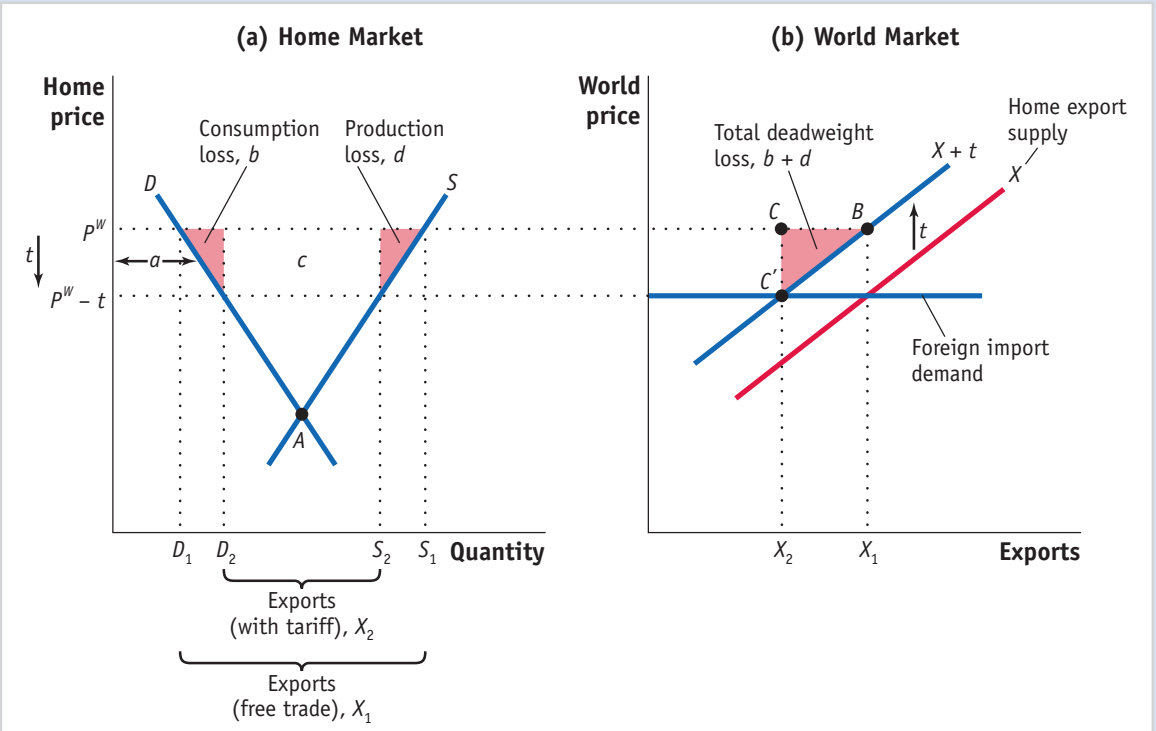
In this section we look at how export tariffs affect the overall welfare of the exporting country, taking into account the effects on consumers, producers, and government revenue. We start with the case of a small exporting country, facing fixed world prices. Following that, we look at how the outcome differs when the country is large enough to affect world prices.

Impact of an Export Tariff in a Small Country

Consider a small country (like Argentina) that exports soybeans. The Home no-trade equilibrium is shown at point A in panel (a) of Figure 10-5. With free trade, Home faces a world price of soybeans of P^W pesos (we are using the currency of Argentina). At that price, the quantity supplied at Home is S_1 and the quantity demanded is D_1 in panel (a), so Home will export soybeans. The quantity of exports is $X_1 = S_1 - D_1$, which is shown by point B in panel (b). So far, the free trade equilibrium in Figure 10-5 is the same as that in Figure 10-1, which showed the impact of an export subsidy. But the two figures will change when we consider the effects of an export tariff.

Now suppose that the government applies a tariff of t pesos to the exports of soybeans. Instead of receiving the world price of P^W, producers will instead receive the price of $P^W - t$ for their exports, because the government collects t pesos. If the price they receive at Home is any higher than this amount, then producers will sell only in the Home market and not export at all. As a result there would be an oversupply at Home and the local price would fall. Thus, in equilibrium, the Home price must also fall to equal the export price of $P^W - t$.

FIGURE 10-5



Export Tariff for a Small Country Panel (a): Applying an export tariff of t pesos per unit exported decreases the price that Home exporters receive from P^W to $P^W - t$. As a result, the domestic price of the similar good also falls by that amount. This price fall leads to a decrease in Home quantity supplied from S_1 to S_2, and an increase in Home quantity demanded from D_1 to D_2, in panel (a). Exports fall due to the tariff, from X_1 to X_2. Panel (b): The Home export supply curve shifts up by the amount of the tariff because the marginal cost of a unit of exports increases by exactly t. The deadweight loss due to the subsidy is the triangle $(b + d)$, the sum of the consumption loss b and production loss d.

With the price falling to $P^W - t$, the quantity supplied in Home falls to S_2, and the quantity demanded increases to D_2 in panel (a). Therefore, Home exports fall to $X_2 = S_2 - D_2$. The change in the quantity of exports can be thought of as a leftward, or upward, shift of the export supply curve in panel (b), where we measure the *world price* rather than the Home price on the vertical axis. The export supply curve shifts up by the amount of the tariff t. This result is analogous to what happened when we introduced a subsidy in Figure 10-1. In that case, the export supply curve fell by the amount of the subsidy s.

The new intersection of supply and demand in the world market is at point C in panel (b), with exports of X_2. Alternatively, on the original export supply curve X, exports of X_2 occur at the point C' and the domestic price of $P^W - t$.

Impact of the Export Tariff on Small Country Welfare We can now determine the impact of the tariff on the welfare of the small exporting country. Since the Home price falls because of the export tariff, consumers benefit. The rise in consumer surplus is shown by area a in panel (a). Producers are worse off, however, and the fall in producer surplus is shown by the amount $(a + b + c + d)$. The government collects revenue from the export tariff, and the amount of revenue equals the amount of the tariff t times exports of X_2, area c.

Adding up the impact on consumers, producers, and government revenue, the overall impact of the export tariff on the welfare of a small exporting country is:

Rise in consumer surplus:	$+ a$
Fall in producer surplus:	$-(a + b + c + d)$
Rise in government revenue:	$+ c$
Net effect on Home welfare:	$\mathbf{-(b + d)}$

To sum up, the export tariff for a small country has a deadweight loss of $(b + d)$. (This outcome is similar to the results of the import tariff that we studied in Chapter 8 and the export subsidy we studied earlier in this chapter.) That loss can be broken up into two components. The triangle b in panel (a) is the consumption loss for the economy. It occurs because as consumers increase their quantity from D_1 to D_2, the amount that they value these extra units varies between P^W and $P^W - t$, along their demand curve. The true cost to the economy of these extra units consumed is always P^W. Therefore, the value of the extra units is less than their cost to the economy, indicating that there is a deadweight loss.

Triangle d is the production loss for the economy. It occurs because as producers reduce their quantity from S_1 to S_2, the marginal cost of supplying those units varies between P^W and $P^W - t$, along their supply curve. But the true value to the economy of these extra units consumed is always P^W, because that is the price at which they could be exported without the tariff. Therefore, the value of the forgone units exceeds their cost to the economy, indicating again that there is a deadweight loss.

Impact of an Export Tariff in a Large Country

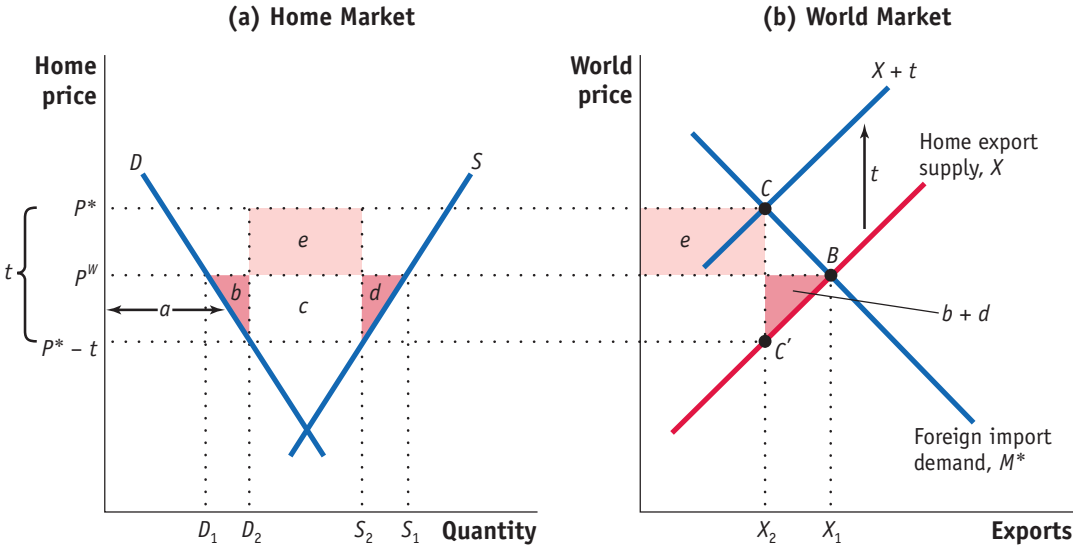
We have shown that the export tariff in a small country leads to a decline in overall welfare. Despite that, some governments—especially in developing countries—find that export tariffs are a convenient way to raise revenue, because it is very easy to apply the tax at border stations as goods leave the country. The fact that the economy overall suffers a loss does not prevent governments from using this policy.

What happens in a large exporting country? Does an export tariff still produce an overall loss? Recall from Chapter 8 that an import tariff in a large country would lead to an overall *gain* rather than a loss, provided that the tariff is not too high. This gain arises because the import tariff reduces demand for the imported product, and therefore lowers its price, which leads to a terms-of-trade gain. In this section, we see that an export tariff also leads to a terms-of-trade gain. That result occurs because an export tariff reduces the amount supplied to the world market, and therefore increases the price of the export product, which is a terms-of-trade gain.

Figure 10-6 illustrates the effect of an export tariff for a large country. Under free trade the price of soybeans is P^W, which is at the intersection of Home export supply X and Foreign import demand M^* in panel (b). When the government applies a tariff of t pesos to soybean exports, the Home export supply curve shifts up by exactly the amount of the tariff from X to $X + t$. The new intersection of the Home export supply curve and the Foreign import demand curve occurs at point C, and the world price has risen from P^W to P^*.

The price P^* is paid by Foreign buyers of soybeans and includes the export tariff. The Foreign import demand curve M^* is downward sloping rather than horizontal as it was in Figure 10-5 for a small country. Because the Foreign import demand curve slopes downward, the price P^* is greater than P^W but not by as much as the tariff t, which equals the upward shift in the export supply curve. Home receives price $P^* - t$,

FIGURE 10-6



Export Tariff for a Large Country The tariff shifts up the export supply curve from X to $X + t$, in panel (b). As a result, the world price increases from P^W to P^*. But this increase in the world price is less than the upward shift in export supply of t. It follows that the Home price decreases from P^W to $P^* - t$, in panel (a). Home quantity demanded increases from D_1 to D_2, and Home quantity supplied decreases from S_1 to S_2. The deadweight loss for Home is the area of triangle $(b + d)$. Because world price rises from P^W to P^*, Home also has a terms-of-trade gain of area e.

which is measured net of the export tariff. Because P^* has risen above P^W by less than the amount t, it follows that $P^* - t$ falls below P^W, as shown in panel (a).

Impact of the Export Tariff on Large Country Welfare We can now determine the impact of the tariff on the welfare of the large exporting country. Home consumer and producers faced the free trade price of P^W under free trade, but face the lower price of $P^* - t$ once the tariff is applied. The rise in consumer surplus is shown by area a in panel (a) and the fall in producer surplus is shown by area $(a + b + c + d)$. The revenue the government collects from the export tariff equals the amount of the tariff t times exports of X_2, by area $(c + e)$.

Adding up the impacts on consumers, producers, and government revenue, the overall impact of the export tariff on the welfare of a large exporting country is:

Rise in consumer surplus:	$+ a$
Fall in producer surplus:	$-(a + b + c + d)$
Rise in government revenue:	$+(c + e)$
Net effect on Home welfare:	$\boldsymbol{e - (b + d)}$

Compared with the effect of an export tariff for a small country, we find that the net effect on large-country Home welfare can be positive rather than negative, as long as $e < (b + d)$. The amount $(b + d)$ is still the deadweight loss; area e is the *terms-of-trade gain* due to the export tariff. In either panel of Figure 10-6, this terms-of-trade gain is measured by the rise in the price paid by Foreign purchasers of soybeans, from P^W to P^*, multiplied by the amount of exports X_2. This terms-of-trade gain is the "extra" money that Home receives from exporting soybeans at a higher price. If the terms-of-trade gain exceeds the deadweight loss, then the Home country gains overall from applying the tariff.

To sum up, the effect of an export tariff is most similar to that of an import tariff because it leads to a terms-of-trade gain. In Chapter 8 we argued that for an import tariff that is not too high, the terms-of-trade gain e would always exceed the deadweight loss $(b + d)$. That argument applies here, too, so that for export tariffs that are not too high, the terms-of-trade gain e exceeds the deadweight loss and Home country gains. In Chapter 8 we stressed that this terms-of-trade gain came at the expense of the Foreign country, which earns a lower price for the product it sells under an import tariff. Similarly, the Foreign country loses under an export tariff because it is paying a higher price for the product it is buying. So, just as we called an import tariff a *beggar-thy-neighbor policy*, the same idea applies to export tariffs because they harm the Foreign country. These results are the opposite of those we found for an export subsidy, which for a large Home country always leads to a terms-of-trade loss for Home and a benefit for Foreign buyers.

6 Export Quotas

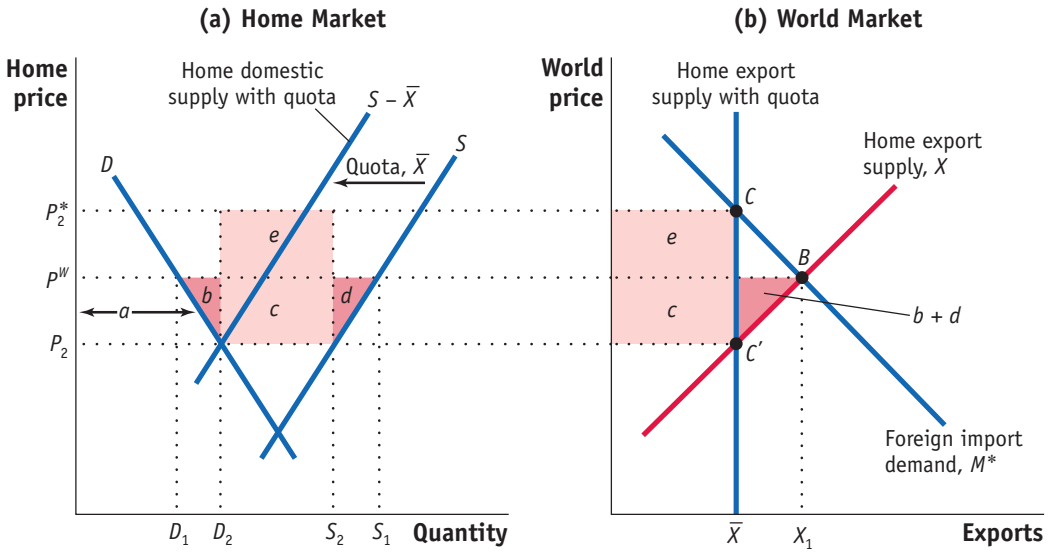
The finding that a large country can gain from an export tariff gives a government an added reason to use this policy, in addition to earning the tariff revenue. There is one other export policy that also benefits the large country applying it: an **export quota,** which is a limit on the amount that firms are allowed to export. The most well-known system of export quotas in the world today is the system used by the Organization of

Petroleum Exporting Countries (OPEC), which includes six countries in the Middle East, four in Africa, and two in South America. OPEC sets limits on the amount of oil that can be exported by each country, and by limiting oil exports in this way, it keeps world petroleum prices high. Those high prices benefit not only OPEC's member countries, but also other oil-exporting countries that do not belong to OPEC. (At the same time, the high prices clearly harm oil-importing countries). The oil companies themselves benefit from the export quotas because they earn the higher prices. Thus, the export quota is different from an export tariff (which is, in effect, a tax on firms that lowers their producer surplus).

We can use Figure 10-7 to illustrate the effect of an export quota. This figure is similar to Figure 10-6 because it deals with a large exporting country. Initially under free trade, the world trade price occurs at the intersection of Home export supply X and Foreign import demand M^*, at point B in panel (b) with exports of X_1. Now suppose that the Home country imposes a quota that limits its exports to the quantity $\overline{X} < X_1$. We can think of the export supply curve as a vertical line at the amount $\overline{X}$. A vertical line at $\overline{X}$ would intersect Foreign import demand at the point C, leading to a higher world price of $P_2^* > P^W$.

That higher world price is earned by the Home producers. But because they export less ($\overline{X}$ rather than the free trade amount X_1), they sell more locally. Local sales can be found by subtracting exports of $\overline{X}$ from the Home supply curve in panel (a), shifting the remaining Home supply left to the curve labeled $S - \overline{X}$. The intersection of

FIGURE 10-7



Export Quota for a Large Country The export quota leads to a vertical export supply curve above the quantity $\overline{X}$ in panel (b). As a result, the world price increases from P^W to P_2^*. Because Home firms can export only the amount $\overline{X}$, the remaining home supply curve shifts left by that amount, as shown by $S - \overline{X}$. This remaining Home supply intersects Home demand at the price P_2 in panel (a), which is lower than the initial world price of P^W. This increase in the world price is less than the upward shift in export supply of t. The deadweight loss for Home is the area of triangle $(b + d)$, while Home firms earn the quota rents of area $(c + e)$.

this remaining Home supply with Home demand occurs at the price P_2 in panel (a), which is lower than the initial world price of P^W. As we found for the export tariff in Figure 10-6, the fall in the Home price leads to an increase in Home demand from D_1 to D_2. That quantity is the amount that Home firms supply to the local market. The *total* amount supplied by Home firms is $D_2 + \overline{X} = S_2$, which has fallen in relation to the free-trade supply of S_1. So we see that a side-effect of the export quota is to limit the total sales of Home firms.

Let's compare the welfare effects of the export quota with those of the export tariff. Home consumers gain the same amount of consumer surplus a due to lower domestic prices. The change in producer surplus is more complicated. If producers earned the lower price of P_2 on *all* their quantity sold, as they do with the export tariff, then they would lose $(a + b + c + d)$ in producer surplus. But under the export quota they also earn rents of $(c + e)$ on their export sales, which offsets the loss in producer surplus. These rents equal the difference between the Home and world prices, $P_2^* - P_2$, times the amount exported $\overline{X}$. A portion of these rents—the area e—is the rise in the world price times the amount exported, or the terms-of-trade gain for the exporter; the remaining amount of rents—the area c—offsets some of the loss in producer surplus. The government does not collect any revenue under the export quota, because the firms themselves earn rents from the higher export prices.

The overall impact of the export quota is:

Rise in consumer surplus:	$+ a$
Fall in producer surplus:	$- (a + b + c + d)$
Rise in rents earned by producers:	$+ (c + e)$
Rise in government revenue:	0
Net effect on Home welfare:	$\boldsymbol{e - (b + d)}$

To summarize, the overall effect of the export quota on the Home country welfare is the same as the export tariff, with a net effect on welfare of $e - (b + d)$. If this amount is positive, then Home gains from the export quota. The effects of the quota on Home firms and the government differ from those of the tariff. Under the export tariff the Home government earns revenue of $(c + e)$, while under the export quota that amount is earned instead as quota rents by Home firms.

This conclusion is the same as the one we reached in Chapter 8, when we examined the ways that import quotas can be allocated. One of those ways was by using a "voluntary" export restraint (VER), which is put in place by the exporting country rather than the importing country. The VER and the export quota are the same idea with different names. In both cases, the restriction on exports raises the world price. Firms in the exporting country can sell at that higher world price, so they earn the quota rents, with no effect on government revenue. In the following application, we look at how China used export quotas to limit its export of some mineral products.

APPLICATION

Chinese Export Policies in Mineral Products

Like many developing countries, China uses a wide variety of export policies. Export tariffs ranging from 10% to 40% are applied to steel products, for example, which create a source of revenue for the government. In addition, China has applied both tariffs and quotas to its exports of mineral products. The policies that China has applied to

mineral exports have attracted international attention recently, since some of these minerals are essential to the production of goods in other countries. As we saw in Figures 10-6 and 10-7, export tariffs and export quotas both increase the world price, making it more expensive for other countries to obtain a product and at the same time benefiting the exporting country with a terms-of-trade gain.

In 2009, the United States, the European Union, and Mexico filed a case against China at the World Trade Organization (WTO), charging that the export tariffs and export quotas that China applied on bauxite, zinc, yellow phosphorus, and six other industrial minerals, distorted the pattern of international trade.[5] Export restrictions of this type are banned under Article XI of the General Agreement on Tariffs and Trade (see **Side Bar: Key Provisions of the GATT,** Chapter 8). When China joined the WTO in 2001, it was required to eliminate its export restrictions, including those on minerals. But an exception to Article XI states that this rule does not apply to "export prohibitions or restrictions temporarily applied to prevent or relieve critical shortages of foodstuffs or other products essential to the exporting contracting party." For example, a country facing a food shortage can restrict its food exports to keep the food at home. In its response to this 2009 case, China claimed that this exception applied to its exports of industrial minerals; China claimed that it was restricting its exports of the minerals because they were needed by Chinese industries using these products (such as the solar panel industry), and also because the export quota would limit the total amount sold of these precious resources and leave more in the ground for future use. But in July 2011, the WTO ruled that this exception did not apply to China's exports of these products, and that it must remove its export restrictions on industrial minerals. China filed an appeal, but the WTO reaffirmed the ruling again in January 2012.

This legal battle at the WTO was closely watched around the world, because shortly after the case was filed in 2009, China also started applying export quotas to other mineral products: "rare earth" minerals, such as lanthanum (used in batteries and lighting) and neodymium (used in making permanent magnets, which are found in high-tech products ranging from smartphones to hybrid cars to wind turbines).[6] At that time, China controlled more than 95% of the world production and exports of these minerals. The export quotas applied by China contributed to a rise in the world prices of these products. For example, the price of lanthanum went from $6 per kilogram in 2009 to $60 in 2010 to $151 in 2011, and then back down to $36 in 2012. The high world prices made it profitable for other nations to supply the minerals: Australia opened a mine and the United States reopened a mine in the Mojave Desert that had closed a decade earlier for environmental reasons. The U.S. mine includes deposits of light rare earth elements, such as neodymium, as well as the heavy rare elements terbium, yttrium, and dysprosium (which are needed to manufacture wind turbines and solar cells).[7] These new sources of supply led to the price drop in 2012.

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[5] The six other minerals are coke, fluorspar, magnesium, manganese, silicon carbide, and silicon metal. The information in this paragraph and the next is drawn from Keith Bradsher, "In Victory for the West, W.T.O. Orders China to Stop Export Taxes on Minerals," *The New York Times*, January 30, 2012, and "Rare Earth Trade Case Against China May Be Too Late" *The New York Times*, March 13, 2012.

[6] There are 17 rare earth minerals, consisting of the 15 lanthanides along with yttrium and scandium. The material in this paragraph is drawn from Jacob Marder, "The Rare Earth Metal Industry," University of California, Davis.

[7] See Kyle Wiens, "A Visit to the Only American Mine for Rare Earth Metals", *The Atlantic*, February 21, 2012, electronic edition.

In March 2012, the United States, the European Union, and Japan filed another WTO case against China charging that it applied unfair export restrictions on its rare earth minerals, as well as tungsten and molybdenum. The first step in such a case is for the parties involved (the United States, Europe, and Japan on one side; China on the other) to see whether the charges can be resolved through consultations at the WTO. Those consultations failed to satisfy either side, and in September 2012, the case went to a dispute settlement panel at the WTO. The Chinese government appealed to Article XX of the GATT, which allows for an exception to GATT rules in cases "relating to the conservation of exhaustible natural resources." But the WTO ruled against China, who is expected to appeal.

Regardless of the ultimate outcome of that case, it appears that China has already changed its policies on rare earth minerals. By the end of 2012, China realized that its policy of export quotas for rare earth minerals was not having the desired effect of maintaining high world prices. It therefore shifted away from a strict reliance on export quotas, and introduced subsidies to help producers who were losing money. These new policies are described in **Headlines: China Signals Support for Rare Earths.** The new subsidy policy might also lead to objections from the United States, the European Union, and Japan. But as we have seen earlier in this chapter, it is more difficult for the WTO to control subsidies (which are commonly used in agriculture) than to control export quotas.

A final feature of international trade in rare earth minerals is important to recognize: the mining and processing of these minerals poses an environmental risk, because rare earth minerals are frequently found with radioactive ores like thorium or uranium. Processing these minerals therefore leads to low-grade radioactive waste as a by-product. That aspect of rare earth minerals leads to protests against the establishment of new mines. The Lynas Corporation mine in Australia, mentioned in the Headlines article, processes the minerals obtained there in Malaysia. That processing facility was targeted by protesters in Malaysia, led by a retired math teacher named Tan Bun Teet. Although Mr. Tan and the other protestors did not succeed in preventing the processing facility from being opened, they did delay it and also put pressure on the company to ensure that the radioactive waste would be exported from Malaysia, in accordance with that country's laws. But where will this waste go? This environmental dilemma arises because of the exploding worldwide demand for high-tech products (including your own cell phone), whose manufacturing involves environmental risks. This case illustrates the potential interaction between international trade and the environment, a topic we examine in more detail in the next chapter. ■

TIM WIMBORNE/Reuters/Corbis

Protesters from the Save Malaysia Stop Lynas group demonstrating outside a hotel in Sydney, Australia.

7 High-Technology Export Subsidies

We turn now to consider high-technology final products. This sector of an economy also receives substantial assistance from government, with examples including subsidies to the aircraft industries in both the United States and Europe. In the United States, subsidies take the form of low-interest loans provided by the Export-Import

HEADLINES

China Signals Support for Rare Earths

China has changed its rare earths policy amid fears that its hard line on producers threatens its dominance of the global market for 17 key substances found in items from smartphones to missiles. In a move that Beijing describes as "promoting orderly development", China will provide direct subsidies to revive struggling producers—a tacit acknowledgment of the strategic importance of the industry. The subsidies represent a significant shift in China's policy of the past two years, which focused on restricting production of rare earths, closing down illegal mines, and tightening control of exports. These moves led to price fluctuations and slowing global demand.

Chen Zhanheng, of the China Rare Earths Industry Association, said the move would help the large, state-controlled rare earths companies the government is trying to promote. "In the long run, the policy can promote resource protection and effective utilisation of rare earths," said Mr. Chen. "[The subsidy] is aimed at supporting technological upgrades, energy conservation and environmental protection."

. . . Beijing's near monopoly in the strategic sector has raised concerns in Washington and Tokyo, particularly when China suspended rare earths shipments to Japan during a diplomatic dispute in 2010. That incident, combined with broader concerns about the reliability of Chinese supply, triggered a surge of investment in mines outside China, several of which are set to start producing next year. Lynas Corporation, an Australia-based miner, announced yesterday that its first shipment of rare earths ore had arrived in Malaysia, where it has a processing facility expected to start producing the substances in the first half of 2013.

Bank to foreign firms or governments that want to purchase aircraft from Seattle-based Boeing. (The Export-Import Bank is a U.S. government agency that finances export-related projects.) On the European side, government support for research and development and other subsidies are given to Airbus, which produces parts and assembles its finished products in a number of European countries. In Japan and South Korea, direct subsidies have been given to high-tech manufacturing firms that achieve certain targets for increasing their export sales. High-tech subsidies are given by many other countries, too.

Why do governments support their high-technology industries? In the case of agricultural products, subsidies are instituted primarily because of the political clout of those industries. Although politics plays a role in subsidies for high-tech industries, governments also subsidize these industries because they may create benefits that spill over to other firms in the economy. That is, governments believe that high-tech industry produces a positive **externality.** This argument for a subsidy is similar to the infant industry argument used to justify protective tariffs (see Chapter 9), except that the protection is applied to an export industry rather than an import-competing industry.

"Strategic" Use of High-Tech Export Subsidies

In addition to the spillover argument for export subsidies, governments and industries also argue that export subsidies might give a **strategic advantage** to export firms that are competing with a small number of rivals in international markets. By a strategic advantage, we mean that the subsidized industry can compete more effectively with its rivals on the world market. Think of the aircraft industry, which currently has just two producers of large, wide-bodied airplanes: Boeing in the United States and Airbus

in Europe. Each of these firms receives some type of subsidy from its government. If high-tech subsidies allow firms to compete more effectively and earn more profits in international markets, and if the extra profits are more than the amount of the subsidy, then the exporting country will obtain an overall benefit from the export subsidy, similar to the benefit that comes from a large country applying a tariff.

To examine whether countries can use their subsidies strategically, we use the assumption of **imperfect competition.** We already used this assumption in Chapter 9, in which we considered the cases of Home monopoly and Foreign monopoly. Now we allow for two firms in the market, which is called a **duopoly.** In that case, each firm can set the price and quantity of its output (and hence maximize its profits) based on the price and quantity decisions of the other firm. When a government uses subsidies to affect this interaction between firms and to increase the profits of its own domestic firm, the government is said to be acting strategically. In this section, we examine the effects of strategic export subsidies to determine whether profits of the exporting firm will rise enough to offset the cost of the subsidy to the government.

Because we now assume that certain high-tech industries operate in imperfectly competitive markets, we need to use a different set of tools to model their supply decisions than we have used thus far in this chapter. To capture the strategic decision making of two firms, we use **game theory,** the modeling of strategic interactions (games) between firms as they choose actions that will maximize their returns. The main goal in this section is to model the strategic interaction of high-tech firms in Home and Foreign, and then to see the impact of export subsidies on their respective decisions and payoffs.

To examine the effect of an export subsidy, we start with the free-trade situation, before any subsidies are in place. Suppose there are two firms that are competing for sales of a new type of aircraft. For example, Airbus sells the double-decker A380, and Boeing sells a smaller aircraft called the 787 Dreamliner (discussed later in the chapter). For convenience, we focus on the decision of each firm to produce a relatively new aircraft that competes with the other firm for sales to the rest of the world. By ignoring sales to firms in their own countries, we will not have to keep track of consumer surplus in the United States or Europe. Instead, the measure of welfare for these countries will depend only on the profits earned by Boeing or Airbus from their sales to the rest of the world.

Payoff Matrix In Figure 10-8, we show a **payoff matrix** for Boeing and Airbus, each of which has to decide whether to produce the new aircraft. Each quadrant of the matrix shows the profit earned by Boeing in the lower-left corner and the profits of Airbus in the upper-right corner. When both firms produce (upper-left quadrant), their prices are reduced through competition, and they both end up making negative profits (i.e., losses) of $5 million.[8]

If Airbus produces the new aircraft and Boeing does not (lower-left quadrant), then Boeing earns nothing, whereas Airbus, the only supplier, earns high profits of $100 million. Conversely, if Boeing produces and Airbus does not (upper-right quadrant), Airbus earns nothing, and Boeing, now the only supplier, earns high profits of $100 million. Finally, if both firms choose not to produce (lower-right quadrant), then they both earn profits of 0.

[8] The numbers we are using in the payoff matrix are made up for convenience, but they illustrate the idea of competition between the firms for the sale of a new aircraft.

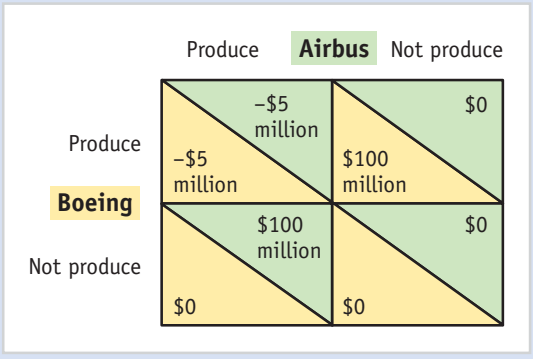
Nash Equilibrium With the pattern of payoffs shown in Figure 10-8, we want to determine what the outcome of this game between the two firms will be. At first glance, this seems like a difficult problem. It is hard for each firm to decide what to do without knowing whether the other firm is going to produce. To solve this problem, we use the concept of the Nash equilibrium, named after John Nash, a winner of the Nobel Prize in economics.[9]

The idea of a **Nash equilibrium** is that each firm must make its own best decision, taking as given each possible action of the rival firm. When each firm is acting that way, the outcome of the game is a Nash equilibrium. That is, the action of each player is the best possible response to the action of the other player.

Best Strategy for Boeing To determine the Nash equilibrium, we proceed by checking each quadrant of the payoff matrix. Let us look at Boeing's possible strategies, starting with the case in which its rival, Airbus, chooses to produce. If Boeing knows that Airbus will produce, then Boeing needs to decide whether to produce. If Boeing produces, then it earns –$5 million (in the upper-left quadrant); if Boeing does not produce, then it earns 0 (in the lower-left quadrant). Therefore, if Airbus produces, then Boeing is better off *not* producing. This finding proves that having both firms produce is not a Nash equilibrium. Boeing would never stay in production, since it prefers to drop out of the market whenever Airbus produces.

Best Strategy for Airbus Let's continue with the case in which Boeing does not produce but Airbus does (lower-left quadrant of Figure 10-8). Is this the best strategy for Airbus? To check this, suppose that Airbus chooses instead not to produce. That would move us from the lower-left quadrant to the lower-right quadrant in Figure 10-8, meaning that Airbus's profits fall from $100 million to 0. This outcome is worse for Airbus, so it would not change its decision: it would still choose to produce. We conclude that the decision illustrated in the lower-left quadrant, with Airbus producing and Boeing not producing, is a Nash equilibrium because each firm is making its best decision given what the other is doing. When Airbus produces, then Boeing's best response is not to produce, and when Boeing does not produce, then Airbus's best response is to produce. There is no reason for either firm to change its behavior from the Nash equilibrium.

FIGURE 10-8



Payoff Matrix Between Two Firms The lower-left number in each quadrant shows the profits of Boeing, and the upper-right number shows the profits of Airbus. Each firm must decide whether to produce a new type of aircraft. A Nash equilibrium occurs when each firm is making its best decision, given the action of the other. For this pattern of payoffs, there are two Nash equilibria, in the upper-right and lower-left quadrants, where one firm produces and the other does not.

[9] The book and movie *A Beautiful Mind* describes the career of John Nash.

Multiple Equilibria Is it possible to find more than one Nash equilibrium? To check for this, we need to check the other quadrants in Figure 10-8. Let us try the case in the upper-right quadrant, where Boeing produces but Airbus does not. Consider Airbus making the decision to produce or not, given that Boeing produces, or Boeing making the decision to produce or not, given that Airbus does not produce. Using the same logic we have already gone through, you can confirm that neither firm would want to change the decision it has made as seen in the upper-right quadrant: if either firm changed its choice, its profits would fall. If Boeing decides not to produce, then its profits fall to 0 (from the upper-right to the lower-right quadrant), whereas if Airbus decides to produce, its profits fall to –$5 million (from the upper-right to the upper-left quadrant). So we conclude that the upper-right quadrant, with Boeing producing and Airbus not producing, is *also* a Nash equilibrium. When Boeing produces, then Airbus's best response is to not produce, and when Airbus does not produce, then Boeing's best response is to produce. Finally, by applying the same logic to the other quadrants, we can confirm that there are no more Nash equilibria.

When there are two Nash equilibria, there must be some force from outside the model that determines in which equilibrium we are. An example of one such force is the **first mover advantage,** which means that one firm is able to decide whether to produce before the other firm. If Boeing had this advantage, it would choose to produce, and Airbus, as the second mover, would not produce, so we would be in the upper-right quadrant. Let us suppose that is the Nash equilibrium from which we start. Because Airbus is not producing, it is making zero profits. In this situation, the government in Europe might want to try to change the Nash equilibrium so that Airbus would instead earn positive profits. That is, by providing subsidies to Airbus, we want to determine whether the payoffs in the matrix change such that the Nash equilibrium also changes.

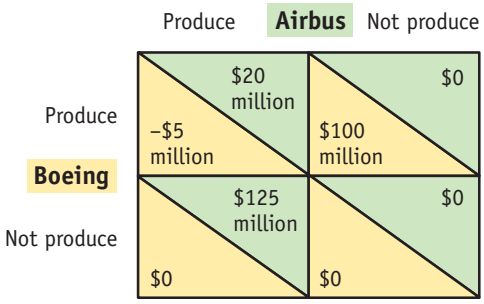
The type of subsidy we consider in our model is a cash payment to Airbus. In practice, however, subsidies are of many kinds: Boeing has benefited from U.S. military contracts, where the research and development (R&D) done for those contracts has been used in its civilian aircraft, too. Airbus, on the other hand, has benefited from direct R&D subsidies to defray the "launch costs" of getting a new aircraft off the ground. Both companies have benefited from low-cost loans provided by their governments to purchasers of aircraft. Later in the chapter, we examine in more detail actual export subsidies that are used in the aircraft industry.

Effect of a Subsidy to Airbus

Suppose the European governments provide a subsidy of $25 million to Airbus. With this subsidy in place, Airbus's profits will increase by $25 million when it produces. In Figure 10-9, we add that amount to the payoffs for Airbus and check to see whether the Nash equilibria have changed. Recall that the free-trade Nash equilibria occur when one firm produces and the other does not.

Best Strategy for Airbus Let us start with the free-trade Nash equilibrium in which Boeing produces but Airbus does not (upper-right quadrant) and see whether it changes when Airbus receives a government subsidy. After the subsidy, that option is no longer a Nash equilibrium: if Boeing is producing, then Airbus is now better off by *also* producing because then it receives a $25 million subsidy from the government. With the subsidy, it will now earn $20 million ($5 million in negative profits plus the $25 million subsidy) even when Boeing produces. Recall that in the original situation, if Boeing produced,

FIGURE 10-9



Payoff Matrix with Foreign Subsidy When the European governments provide a subsidy of $25 million to Airbus, its profits increase by that much when it produces a new aircraft. Now there is only one Nash equilibrium, in the lower-left quadrant, with Airbus producing but Boeing not producing. The profits for Airbus have increased from 0 to $125 million, while the subsidy cost only $25 million, so there is a net gain of $100 million in European welfare.

then Airbus would not choose to produce because otherwise it would lose $5 million. With the subsidy, Airbus now earns $20 million by producing instead of losing $5 million.

Best Strategy for Boeing Is this new position a Nash equilibrium? To answer that, we need to see whether Boeing would still be making the right decision given that Airbus is producing. When Airbus produces, Boeing loses $5 million when it produces (upper-left quadrant) but loses nothing when it does not produce (lower-left quadrant). Therefore, Boeing will want to drop out of the market. Once Boeing makes the decision not to produce, Airbus's decision doesn't change. It still chooses to produce, but its payoff increases dramatically from $20 million to $125 million, and we move to the lower-left quadrant, with Airbus producing and Boeing not.

Nash Equilibrium You can readily check that the lower-left quadrant is a unique Nash equilibrium: each firm is making its best decision, given the action of the other. Furthermore, it is the *only* Nash equilibrium. The effect of the European governments' subsidy has been to shift the equilibrium from having Boeing as the only producer (where we started, in the upper-right quadrant) to having Airbus as the only producer (in the lower-left quadrant).

European Welfare The European subsidy has had a big impact on the equilibrium of the game being played between the two firms. But can we necessarily conclude that Europe is better off? To evaluate that, we need to add up the welfare of the various parties involved, much as we did earlier in the chapter.

The calculation of European welfare is simplified, however, because of our assumption that production is for export to the rest of the world. From Europe's point of view, we do not need to worry about the effect of the subsidy on consumer surplus in its own market. The only two items left to evaluate, then, are the profits for Airbus from its sales to the rest of the world and the cost of the subsidy to the European government.

Airbus's profits have increased from 0 (when it was not producing but Boeing was) to $125 million (now that Airbus is producing but Boeing is not). The revenue cost of the subsidy to Europe is $25 million. Therefore, the net effect of the subsidy on European welfare is

Rise in producer surplus:	+ 125
Fall in government revenue:	– 25
Net effect on European welfare:	**+ 100**

In this case, the subsidy led to a net gain in European welfare because the increase in profits for Airbus is more than the cost of the subsidy.[10]

Subsidy with Cost Advantage for Boeing

Our finding that the subsidy can raise European welfare depends on the numbers we assumed so far, however. Let us now consider another case in which Boeing has a cost advantage over Airbus. In this case, we assume that the cost advantage is the result not of U.S. subsidies but of U.S. comparative advantage in aircraft production.

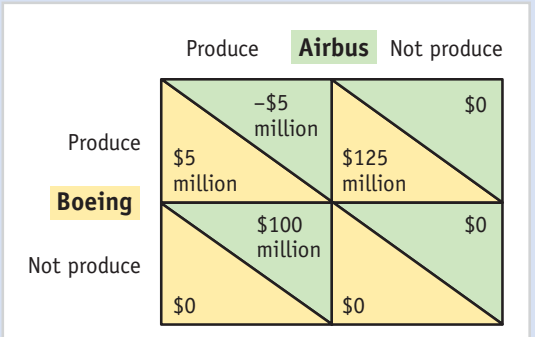
When Boeing has a cost advantage in aircraft production, the payoff matrix is as shown in Figure 10-10. Boeing earns profits of $5 million when both firms produce and profits of $125 million when Airbus does not produce. There is now only one Nash equilibrium, and it is in the upper-right quadrant in which Boeing produces and Airbus does not. The alternative free-trade Nash equilibrium in Figure 10-8 (in which Airbus produces and Boeing does not) is no longer a Nash equilibrium because—with the cost advantage we are now assuming Boeing has, even if Airbus chooses to produce—it is better for Boeing to produce and earn profits of $5 million than not produce and earn 0 profits.

Now suppose, once again, that the European governments provide a $25 million subsidy to Airbus. We add that amount to the payoffs of Airbus when it produces (still assuming that Boeing has a cost advantage over Airbus), as shown in Figure 10-11.

Best Strategy for Airbus Let's see how the subsidy has affected the previous Nash equilibrium in which Boeing produces and Airbus does not (upper-right quadrant). Given that Boeing produces, the decision not to produce is no longer the best one for Airbus: with the subsidy now in place and Boeing producing, Airbus's best decision is to produce and to earn profits of $20 million (upper-left quadrant) rather than 0.

Best Strategy for Boeing Is this new position a Nash equilibrium? Once again, we need to check to see whether, given Airbus's new post-subsidy decision to produce, Boeing is still making the right decision. Given that Airbus produces, then Boeing earns profits of $5 million when it produces and 0 when it does not. Therefore,

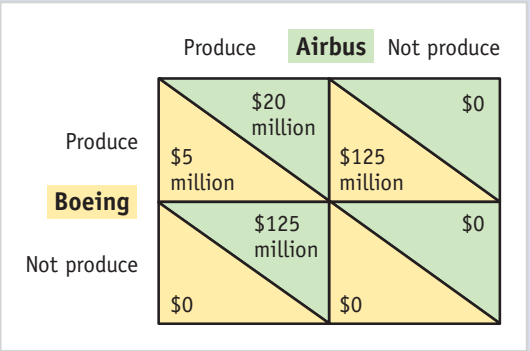
FIGURE 10-10



Another Payoff Matrix, with Boeing Cost Advantage If Boeing has a cost advantage in the production of aircraft, the payoffs are as shown here. Boeing earns profits of $5 million when both firms are producing and profits of $125 million when Airbus does not produce. Now there is only one Nash equilibrium, in the upper-right quadrant, where Boeing produces and Airbus does not.

[10] Notice that if the initial equilibrium was one in which Airbus produced and Boeing did not, then the only effect of the subsidy would be to make this equilibrium unique; it would not change the decision of either firm. Moreover, the effect on total European welfare would be zero because the subsidy would be just a transfer from the European government to Airbus.

FIGURE 10-11



Another Payoff Matrix with Foreign Subsidy When the European governments provide a subsidy of $25 million to Airbus, its profits increase by that much when it produces. Now the only Nash equilibrium is in the upper-left quadrant, where both firms produce. The profits for Airbus have increased from 0 to $20 million, but the subsidy costs $25 million, so there is a net loss of $5 million in European welfare.

Boeing will stay in the market, and we have proved that having both firms produce is a Nash equilibrium.

European Welfare Once Again When Boeing has a cost advantage, the European subsidy allows Airbus to enter the market, but it *has not* resulted in the exit of Boeing as it did in the earlier no-cost-advantage scenario. Let us evaluate the effect on European welfare under these circumstances.

Airbus's profits have increased from 0 (when it was not producing, but Boeing was) to 20 (now that both firms are producing). The revenue cost of the subsidy to Europe is still 25. Therefore, the net effect of the subsidy on European welfare is

Rise in producer profits:	+ 20
Fall in government revenue:	– 25
Net effect on European welfare:	**– 5**

When Boeing has a cost advantage, then, the subsidy leads to a *net loss* in European welfare because the increase in profits for Airbus is less than the cost of the subsidy.

Summary The lesson that we should draw from these various examples is that under conditions of imperfect competition, a subsidy by one government to its exporting firm might increase welfare for its nation, but it might not. Although profits for the exporting firm certainly rise, there is an increase in welfare only if profits rise by more than the cost of the subsidy. This condition is more likely to be satisfied if the subsidy leads to the *exit* of the other firm from the market. In that case, the profits earned by the single firm could very well exceed the cost of the subsidy. When both firms remain in the market after the subsidy, however, it is unlikely that the increase in profits for the subsidized firm will exceed the subsidy cost. In the following application, we are especially interested in whether subsidies in the aircraft industry have kept one firm out of a market segment in which another produces.

APPLICATION

Subsidies to Commercial Aircraft

In the large passenger aircraft industry, there have been just three competitors: Boeing and McDonnell-Douglas in the United States and Airbus in Europe. The former two companies merged on August 1, 1997, so the industry effectively became a duopoly.

The United States and Europe have used various types of subsidies to support their respective firms. First, there are indirect subsidies that arise because in the production of civilian and military aircraft, the research and development (R&D) for the military versions effectively subsidize R&D for the civilian aircraft. These indirect subsidies have benefited both McDonnell-Douglas and Boeing in the United States. Second, the government might directly subsidize the R&D costs of a new aircraft, as Europe subsidizes R&D at Airbus. Third, the government can subsidize the interest rates that aircraft buyers pay when they borrow money to purchase aircraft. Europe and the United States both provide such low-interest loans, for instance, through the Export-Import Bank in the United States as mentioned previously.

1992 Agreement Recognizing that these subsidies are ultimately costly, the United States and the European Community reached an agreement to limit them in 1992. The main features of this agreement are summarized in Table 10-2. Development subsidies are limited to 33% of the total development costs of a new aircraft, and it is expected that the aircraft manufacturers will repay these subsidies at the government interest rate. In addition, the agreement limits indirect (military) subsidies to not more than 4% of any firm's annual sales, prohibits production subsidies, and limits the ability of government agencies to subsidize the interest rate on purchases of aircraft. According to one estimate, this agreement reduced subsidies by between 7.5% and 12.5% of the costs of production. As a result of the reduction in subsidies, prices for aircraft rose by somewhere between 3.1% and 8.8%. This agreement between the United States and Europe benefited the countries' governments because they no longer had to spend the money on the subsidies, and most likely also benefited the aircraft companies because prices rose, but the higher prices led to welfare losses for the purchasing countries.

The Superjumbo There are recent claims that the terms of the 1992 agreement were violated by Airbus as it launched its newest aircraft: the double-decker A380, which is even larger than the Boeing 747 and will compete directly with the 747 in long flights. This "superjumbo" aircraft carries up to 555 passengers and consists of two passenger decks for its entire length. Its first test flight in Europe took place in April 2005, and its first commercial flight to the United States was in March 2007. The expenditures to develop the A380 are estimated to have been $12 billion, one-third of which the governments of France, Germany, the Netherlands, Belgium, Spain, Finland, and the United Kingdom are expected to pay. The European governments provided some $3.5 billion in low-interest loans to cover development costs. In 2005 both the United States and the European Union filed countercomplaints at the World Trade Organization (WTO) regarding illegal subsidies by the other party to their respective aircraft producers. Europe was accused of "illegally" subsidizing the A380, while the United States was accused of subsidizing the development of Boeing's 787 commercial jet. The complaints at the WTO have been going on since 2004, as discussed in **Headlines: EU Seeks $12 billion from U.S. over Boeing Aid.**

Both Airbus and Boeing have filed cases against each other at the WTO, claiming that the subsidies given for the A380 and the 787 aircraft violated the terms of the 1992 Agreement on Trade in Civil Aircraft. In bringing the initial case to the WTO in 2004, the United States declared that it would no longer abide by the 1992 Agreement, which the United States felt had outlived its usefulness. Over the years, the WTO has ruled in favor of both companies, finding that the European Union gave up to $18 billion in subsidized financing to Airbus, while the United States

TABLE 10-2

Provisions of the 1992 Agreement between the United States and the European Community on Trade in Civil Aircraft This table shows the major provisions of a 1992 agreement between the United States and Europe that limited the subsidies provided to the development and production of civilian aircraft.

Aircraft Covered
- All aircraft of 100 seats or larger are subject to the provisions of the agreement.

Direct Support Levels
- Funds advanced by governments for aircraft development may not exceed 33% of total development costs and are to be provided only to programs in which there is a reasonable expectation of recoupment within 17 years.

Interest Rates
- Airbus will repay the first 25% of total development costs at the government cost of borrowing within 17 years of first disbursement; the remaining 8% will be repaid at the government cost of borrowing plus 1% within 17 years of first disbursement.

Indirect Supports
- Both sides agree that indirect (i.e., military) supports should neither confer unfair advantage on manufacturers of civil aircraft nor lead to distortions in international trade in such aircraft.
- Identifiable benefits from indirect support are limited to 3% of the value of industry-wide turnover in each signatory and 4% of the value of each firm's annual sales. Benefits will primarily be calculated as cost reductions in the development of a civil aircraft program realized from technology acquired through government R&D programs.

Escape Clause on Emergency Aid
- Either side can temporarily derogate from the agreement, with the exception of the development support provisions, if survival and financial viability of an aircraft manufacturer are in jeopardy. Any such withdrawal would require consultations with representatives of the other side, full disclosure of information to justify the withdrawal, and full explanation of the remedy to be used.

Production Supports
- No further production subsidies are allowed.

Dispute Settlement Mechanisms
- Both sides will consult at least twice a year to ensure the functioning of the agreement. Either side may request consultations related to the agreement at any time. Such consultations must be held no later than 30 days after they are requested.

Source: Excerpted from Laura D'Andrea Tyson, 1992, Who's Bashing Whom? Trade Conflict in High Technology Industries *(Washington, D.C.: Peterson Institute for International Economics).*

gave up to $4 billion in subsidized financing to Boeing. Both governments are now requesting that they be permitted to apply "countermeasures" against the other countries, which means that they can apply tariffs against products imported from those countries in retaliation for the subsidies. We do not know at this point whether these tariffs will be permitted, and it will probably be years before this complex case is ever resolved at the WTO.

National Welfare Will the development subsidies provided by the European governments to the Airbus A380 increase their national welfare? From the theory presented previously, that outcome is more likely to happen if Airbus is the only firm producing in that market. And such is the case, because Boeing did not try to produce a double-decker aircraft to compete with the A380. Instead, it modified its 747 jumbo jet model to compete with the A380, and it focused its R&D on its new 787 Dreamliner, a midsized (250-passenger), wide-bodied aircraft.

Because Boeing did not enter the market with its own double-decker aircraft, it is possible that the profits earned by Airbus will be large enough to cover the subsidy costs, the criterion for an increase in national welfare. But that outcome is certainly not guaranteed. The profits earned by Airbus on the A380 will depend on how many aircraft are sold and at what price. Airbus has stated that it needs to produce at least

250 planes to cover its development costs but that it expects to sell 1,500 A380s over the next 20 years. As of April 2013, it had delivered 101 of 262 aircraft ordered and was experiencing a slow-down in new orders because of small cracks discovered in the aircraft wings. These cracks have been traced to faulty brackets connecting the wings to the body, and all A380 aircraft in operation will be serviced to repair this defect. Boeing believes that market demand for the A380 superjumbo will not exceed 700 aircraft over the next 20 years. It remains to be seen whether the subsidies provided by the European Union for the A380 will ultimately pay off.

Boeing has its own share of difficulties with the production of the 787 Dreamliner, which was initially scheduled for delivery in 2008, but did not make its first flight until December 15, 2009. Boeing outsourced many of the components of the 787 to firms in other countries, but then had difficulty in assembling these components back in the United States, which led to the delay in its delivery. Then, in January 2013, there were battery fires in two 787 aircraft owned by Japan Air and United Airlines. Those fires led to the grounding of all 787 aircraft until the battery problem could be addressed and solved. The planes were allowed to fly again in June 2013. Finally, note that Airbus has produced a competitor for the 787 Dreamliner, the A350 wide-bodied jet, which had its maiden take-off on June 14, 2013. Boeing and Airbus will be in direct competition for customers for these new aircraft. France, Germany, and Britain pledged $4.1 billion in launch funding for the A350, and it remains to be seen whether this funding will lead to another legal case at the WTO. The fact that both firms are producing a new midsized, wide-bodied aircraft makes it less likely that either country will recoup the subsidies provided and experience a rise in national welfare from the subsidies. ■

AP Photo/Elaine Thompson

AP Photo/Bob Edme

The Boeing 787 (top) and the Airbus A350 (bottom) will compete in the wide-body aircraft market.

8 Conclusions

Countries use export subsidies in a wide range of industries, including agriculture, mining, and high technology. For agriculture, the underlying motivation for the export subsidies is to prop up food prices, thereby raising the real incomes of farmers. This motivation was also discussed at the end of Chapter 3 using the specific-factors model. In this chapter, we used supply and demand curves to analyze the effect of export subsidies, but obtain the same result as in the specific-factors model: export subsidies raise prices for producers, thereby increasing their real income (in the specific-factors model) and their producer surplus (using supply curves).

Shifting income toward farmers comes with a cost to consumers, however, because of the higher food prices in the exporting country. When we add up the loss in consumer surplus, the gain in producer surplus, and the revenue cost of the subsidy, we obtain a net loss for the exporting country as a result of the subsidy. This deadweight loss is similar to that from a tariff in a small country. On the other hand, for a large country, an import tariff and an export subsidy have different welfare implications. Both policies lead to a rise in domestic prices (of either the import good or the export good) and a fall in world prices. For an export subsidy, however, the fall in world prices is a terms-of-trade loss for the exporting country. This means that applying an export subsidy in a large exporting country leads to even greater losses than applying

HEADLINES

EU Seeks $12 billion from US over Boeing Aid

The EU has asked the World Trade Organisation for permission to levy up to $12bn in punitive tariffs against US goods for Washington's failure to dismantle illegal subsidies for Boeing, the aircraft maker. The EU request is the highest on record for so-called countermeasures in a WTO trade case and marks the latest turn in a eight year, tit-for-tat fight between the world's largest civil aircraft. . . .

The US in December made a similar demand for up to $10bn in countermeasures against the EU after it complained that European governments had not complied with a WTO ruling to remove illegal subsidies for Airbus. Under WTO rules, countermeasures allow a government to raise tariffs on goods from another country to recoup damages. The US and EU have previously hit politically sensitive items, such as Florida orange juice and French cheese.

The Boeing-Airbus dispute dates back to 2004, when each government filed complaints at the WTO, saying the other had lavished vast amounts of illegal subsidies on its civil aircraft maker, such as cheap financing, tax breaks, defense contracts and research and development aid. After years of litigation, both sides were ultimately found to have been guilty, although the sums for Airbus, at about $18bn, were more than four-times higher.

Nkenge Harmon, a spokeswoman for the US trade representative, said: "It is truly difficult to see how the EU characterises the finding against the US as the "worst loss" ever. "The WTO found that the EU granted $18bn in subsidised financing, which caused 342 lost sales for the United States. The WTO found $2bn to $4bn, mostly in subsidised research, against the United States, with 118 lost sales for Airbus," she added. . . .

Airbus said the company was "grateful to the EU Commission for taking consequential action," and urged Boeing to come to the bargaining table. "We regret that Boeing continues a legal battle that should have long been resolved by a mutual agreement. We made offers time and again but are ready to fight it through if the other side wishes to do so."

Source: Joshua Chaffin, Andrew Parker, and Alan Beattie, "EU seeks $12bn from US over Boeing aid," Global Economy, September 27, 2012. From the Financial Times

it to a small country: there is no possibility of gain, as we found for a large-country import tariff.

The losses arising from an export subsidy, for either a small or a large country, are less severe when we instead consider production subsidies. A production subsidy provides a farmer with an extra payment for every unit produced, regardless of whether it is sold at home or abroad. So consumer prices do not change from their world level. Since consumer prices are not affected, exports increase only because domestic supply increases. In other words, the excess supply in response to production subsidies will indirectly spill over into international markets but production subsidies do not exclusively subsidize those exports (as export subsidies do). For these reasons, the losses arising from production subsidies in an exporting country are less severe than the losses arising from export subsidies. At the Hong Kong meeting of the WTO in December 2005, countries agreed to eliminate export subsidies in agriculture by 2013, but that agreement was not ratified and has not been implemented. In addition, the countries made a much weaker agreement for production subsidies and other domestic farm supports.

The losses experienced by an exporting country due to subsidies are reversed when countries instead use export tariffs, as occurs for some natural resource products. With export tariffs in a large country, the exporter obtains a terms-of-trade gain through restricting supply of its exports and driving up the world price. This terms-of-trade gain comes at the expense of its trade partners who are buying the products, so like an import tariff, and export tariff is a "beggar thy neighbor" policy.

The losses experienced by an exporting country due to subsidies also change when we consider high-technology industries, operating under imperfect competition. In

this chapter, we examined an international duopoly (two firms) producing a good for sale in the rest of the world: Boeing and Airbus, competing for sales of a new aircraft. We showed that it is *possible* for an export subsidy to lead to gains for the exporting country, by increasing the profits earned by the exporting firms by more than the cost of the subsidy. But that result often requires the subsidy to force the other firm out of the market, which does not necessarily occur. In this case, if both firms stay in the market and are subsidized by their governments, then it is unlikely that the subsidies are in the national interest of either the United States or the European Union; instead, the countries purchasing the aircraft gain because of the lower price, while the United States and Europe lose as a result of the costs of the subsidies.

KEY POINTS

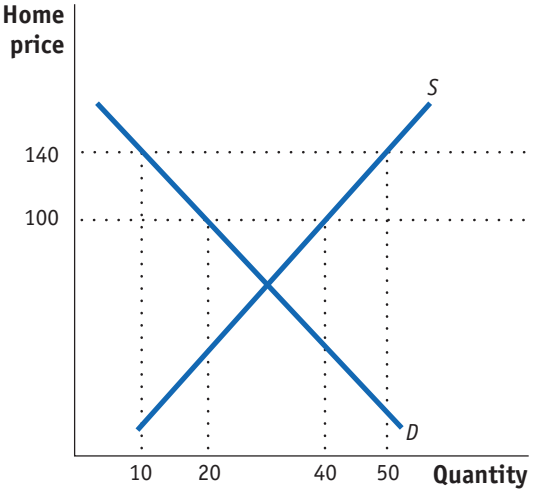
1. An export subsidy leads to a fall in welfare for a small exporting country facing a fixed world price. The drop in welfare is a deadweight loss and is composed of a consumption and production loss, similar to an import tariff for a small country.
2. In the large-country case, an export subsidy lowers the price of that product in the rest of the world. The decrease in the export price is a terms-of-trade loss for the exporting country. Therefore, the welfare of the exporters decreases because of both the deadweight loss of the subsidy and the terms-of-trade loss. This is in contrast to the effects of an import tariff in the large-country case, which generates a terms-of-trade gain for the importing country.
3. Export subsidies applied by a large country create a benefit for importing countries in the rest of the world, by lowering their import prices. Therefore, the removal of these subsidy programs has an adverse affect on those countries. In fact, many of the poorest countries are net food importers that will face higher prices as agricultural subsidies in the European Union and the United States are removed.
4. Production subsidies to domestic producers also have the effect of increasing domestic production. However, consumers are unaffected by these subsidies. As a result, the deadweight loss of a production subsidy is less than that for an equal export subsidy, and the terms-of-trade loss is also smaller.
5. Export tariffs applied by a large country create a terms-of-trade gain for these countries, by raising the price of their export product. In addition, the export tariff creates a deadweight loss. If the terms-of-trade gain exceeds the deadweight loss, then the exporting countries gain overall.
6. It is common for countries to provide subsidies to their high-technology industries because governments believe that these subsidies can create a strategic advantage for their firms in international markets. Because these industries often have only a few global competitors, we use game theory (the study of strategic interactions) to determine how firms make their decisions under imperfect competition.
7. A Nash equilibrium is a situation in which each player is making the best response to the action of the other player. In a game with multiple Nash equilibria, the outcome can depend on an external factor, such as the ability of one player to make the first move.
8. Export subsidies can affect the Nash equilibrium of a game by altering the profits of the firms. If a subsidy increases the profits to a firm by more than the subsidy cost, then it is worthwhile for a government to undertake the subsidy. As we have seen, though, subsidies are not always worthwhile unless they can induce the competing firm to exit the market altogether, which may not occur.

KEY TERMS

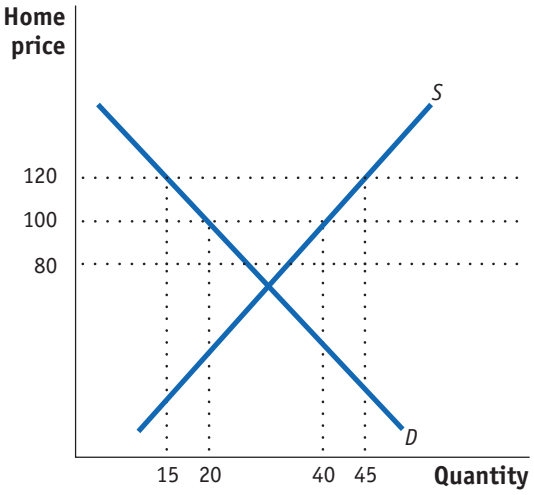
export subsidy, p. 329
Common Agricultural Policy (CAP), p. 330
indirect subsidies, p. 330
domestic farm supports, p. 330
deadweight loss, p. 334
production loss, p. 334
consumption loss, p. 334
production subsidy, p. 340
targeting principle, p. 342
export tariff, p. 343
export quota, p. 347
externality, p. 352
strategic advantage, p. 352
imperfect competition, p. 353
duopoly, p. 353
game theory, p. 353
payoff matrix, p. 353
Nash equilibrium, p. 354
first mover advantage, p. 355

PROBLEMS

1. Describe the impact of each of the following goals from the Hong Kong WTO meeting on (i) domestic prices and welfare of the country taking the action and (ii) world prices and welfare for the partner countries.
   a. Elimination of agriculture export subsidies
   b. Reduction of agricultural tariffs
   c. Duty-free, quota-free access for 97% of goods originating in the world's least developed countries
2. Consider a large country with export subsidies in place for agriculture. Suppose the country changes its policy and decides to cut its subsidies in half.
   a. Are there gains or losses to the large country, or is it ambiguous? What is the impact on domestic prices for agriculture and on the world price?
   b. Suppose a small food-importing country abroad responds to the lowered subsidies by lowering its tariffs on agriculture by the same amount. Are there gains or losses to the small country, or is it ambiguous? Explain.
   c. Suppose a large food-importing country abroad reciprocates by lowering its tariffs on agricultural goods by the same amount. Are there gains or losses to this large country, or is it ambiguous? Explain.
3. Suppose Home is a small exporter of wheat. At the world price of $100 per ton, Home growers export 20 tons. Now suppose the Home government decides to support its domestic producer with an export subsidy of $40 per ton. Use the following figure to answer these questions.

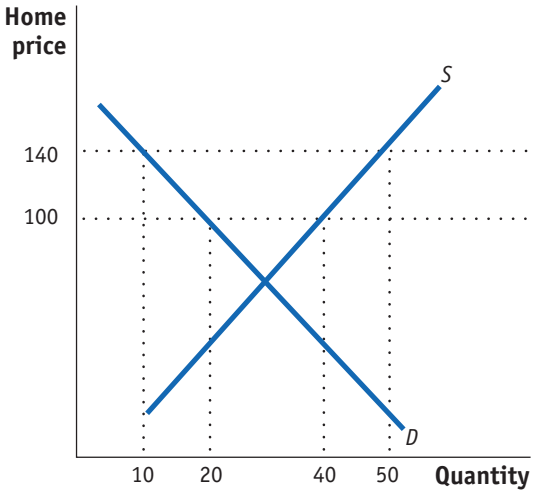


   a. What is the quantity exported under free trade and with the export subsidy?
   b. Calculate the effect of the export subsidy on consumer surplus, producer surplus, and government revenue.
   c. Calculate the overall net effect of the export subsidy on Home welfare.
4. Refer to Problem 3. Rather than a small exporter of wheat, suppose that Home is a large country. Continue to assume that the free-trade world price is $100 per ton and that the Home government provides the domestic producer with an export subsidy in the amount of $40 per ton. Because of the export subsidy, the local price increases to $120, while the foreign market price declines to $80 per ton. Use the following figure to answer these questions.



a. Relative to the small-country case, why does the new domestic price increase by less than the amount of the subsidy?
b. Calculate the effect of the export subsidy on consumer surplus, producer surplus, and government revenue.
c. Calculate the overall net effect of the export subsidy on Home welfare. Is the large country better or worse off as compared to the small country with the export subsidy? Explain.

5. Refer to Problem 3. Suppose Home is a small exporter of wheat. At the world price of $100 per ton, Home growers export 20 tons. But rather than an export subsidy, suppose the Home government provides its domestic producer with a production subsidy of $40 per ton. Use the following figure to answer these questions.



a. What is the quantity exported with the production subsidy?
b. Calculate the effect of the production subsidy on consumer surplus, producer surplus, and government revenue.
c. Calculate the overall net effect of the production subsidy on Home welfare. Is the cost of the production subsidy more or less than the cost of the export subsidy for the small country? Explain.

6. Explain why the WTO is more concerned with the use of direct export subsidies than production subsidies in achieving the same level of domestic support.

7. Boeing and Airbus are the world's only major producers of large, wide-bodied aircrafts. But with the cost of fuel increasing and changing demand in the airline industry, the need for smaller regional jets has increased. Suppose that both firms must decide whether they will produce a smaller plane. We will assume that Boeing has a slight cost advantage over Airbus in both large and small planes, as shown in the payoff matrix below (in millions of U.S. dollars). Assume that each producer chooses to produce only large, only small, or no planes at all.
   a. What is the Nash equilibrium of this game?
   b. Are there multiple equilibria? If so, explain why. *Hint*: Guess at an equilibrium and then check whether either firm would want to change its action, given the action of the other firm. Remember that Boeing can change only its own action, which means moving up or down a column, and likewise, Airbus can change only its own action, which means moving back or forth on a row.
8. Refer to Problem 7. Now suppose the European government wants Airbus to be the sole producer in the lucrative small-aircraft market. Then answer the following:
   a. What is the minimum amount of subsidy that Airbus must receive when it produces small aircraft to ensure that outcome as the unique Nash equilibrium?
   b. Is it worthwhile for the European government to undertake this subsidy?
9. Here we examine the effects of domestic sales taxes on the market for exports, as an example of the "targeting principle." For example, in the domestic market, there are heavy taxes on the purchase of cigarettes. Meanwhile, the United States has several very large cigarette companies that export their products abroad.
   a. What is the effect of the sales tax on the quantity of cigarette exports from the United States? *Hint:* Your answer should parallel the case of production subsidies but for a consumption tax instead.
   b. How does the change in exports, if any, due to the sales tax compare with the effect of an export subsidy on cigarettes?
10. Refer to Problem 9. Based on your answer there, would foreign countries have a reason to object to the use of a sales tax on cigarettes by the United States? Based on your knowledge of the GATT/WTO provisions (see **Side Bar: Key Provisions of the GATT** in Chapter 8), are foreign countries entitled to object to the use of such a tax?
11. To improve national welfare, a large country would do better to implement an export subsidy rather than an import tariff. Is this true or false? Explain why.
12. Who gains and who loses when governments in Europe and the United States provide subsidies to Airbus and Boeing?
13. Provide motivations for the use of export subsidies. Does your answer depend on whether firms compete under perfect or imperfect competition?

		Airbus		
		Large planes	Small planes	Not produce
Boeing	Large planes	−5 / 10	125 / 115	0 / 115
	Small planes	100 / 150	0 / 15	0 / 150
	Not produce	100 / 0	125 / 0	0 / 0