



international
economics

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5 High-Technology Export Subsidies

We turn now from the discussion of export subsidies in agriculture to consider an industry at the other end of the technological spectrum: high-technology products. That sector of the economy also receives substantial assistance from the 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 Bank (a U.S. government agency that finances export-related projects) to foreign firms or governments that want to purchase aircraft from Seattle-based Boeing. 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 achieved 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. While politics also 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-body 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 when a large country applies 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 are now assuming that certain high-tech industries operate in imperfectly competitive markets, we will need to use a different set of tools to model their supply decisions than we have 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 recently began selling the double-decker A380, and Boeing is developing a smaller aircraft called the 787 Dreamliner (discussed later in the chapter). For convenience, we focus on the decision of each firm to develop a new aircraft that competes with the other firm for sales to the rest of the world. By ignoring sales to 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 10-5, 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 (that is, losses) of \$5 million. If Airbus produces the new aircraft and Boeing does not (lower-left quadrant), then Boeing earns nothing while 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 to produce (lower-right quadrant), then they both earn profits of 0.

Nash Equilibrium With the pattern of payoffs shown in Figure 10-5, 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 or not. To solve this problem, we use the concept of the Nash equilibrium, named after John Nash, a winner of the Nobel Prize in economics.

⁴ 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.

⁵ The book and movie *A Beautiful Mind* describes the career of John Nash.

FIGURE 10-5

Payoff Matrix

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		Airbus	
		Produce	Not produce
Boeing	Produce	-\$5 million	\$0
	Not produce	\$0	\$0

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.

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 or not. 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 10-5). Is this the best strategy for Airbus? To check this, suppose that Airbus chooses instead to not produce. That would move us from the lower-left quadrant to the lower-right quadrant in Figure 10-5, 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 to not 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.

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 10-5. 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), while 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 which equilibrium we are in. An example of one such force is the **first mover advantage**, which means that one firm is able to decide whether or not 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 R&D done for those contracts has been used in its civilian aircraft, too. Airbus, on the other hand,

has benefited from getting a low-cost indirect subsidy. **Quid Pro Quo** therefore not have General I chapter, v the aircraft

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Source: Excerpt

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. An indirect type of subsidy, described by **Headlines: Airbus, China and Quid Pro Quo**, takes place when Airbus builds a plant in China and therefore ensures that China will order that aircraft. (While Boeing does not have a production line in China, it obtains some of its engines from General Electric, which has numerous partnerships in China.) 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

HEADLINES

Airbus, China and Quid Pro Quo

This article discusses the ways in which Boeing and Airbus compete to obtain sales in the Chinese market, such as by building a plant there.

Airbus is in the late stages of negotiations to build an assembly line for its A320 passenger plane in China, a landmark deal that would significantly lift its prospects for business there. Producing European planes in China would open a new front in the battle between Airbus and Boeing for the world’s next great aviation market, as well as underscore the growing role of state enterprises in the global economy. Four Chinese cities are vying for the plant, which would produce up to four A320’s a month, in cooperation with Chinese state-owned aerospace manufacturers, industry experts said. The A320 is a short-haul jet that serves primarily domestic routes, which are booming across China.

... Airbus has put China at the center of its expansion plans, aiming to capture half of a market that it thinks

could nearly double, to 1,790 aircraft, by 2022. Airbus has 344 planes in service in China, Hong Kong and Macao, but Boeing still dominates, with nearly two-thirds of the market. In December, China placed an order for 150 A320’s with a [total combined] list price of close to \$10 billion. China and Airbus announced the order during a visit to France by China’s Prime Minister, Wen Jiabao, when Airbus pledged to consider the production line.

Analysts interpreted the announcement as a *quid pro quo*, showing the lengths to which Airbus has had to go to break into the Chinese market, despite being active there since 1985. George Behan, a spokesman for Representative Norman Dicks, a Democrat from Washington State, where Boeing’s commercial aircraft division is based, said he saw little surprise in Airbus’s moves:

“This is Airbus’s modus operandi, the way they intend to compete with Boeing internationally.”

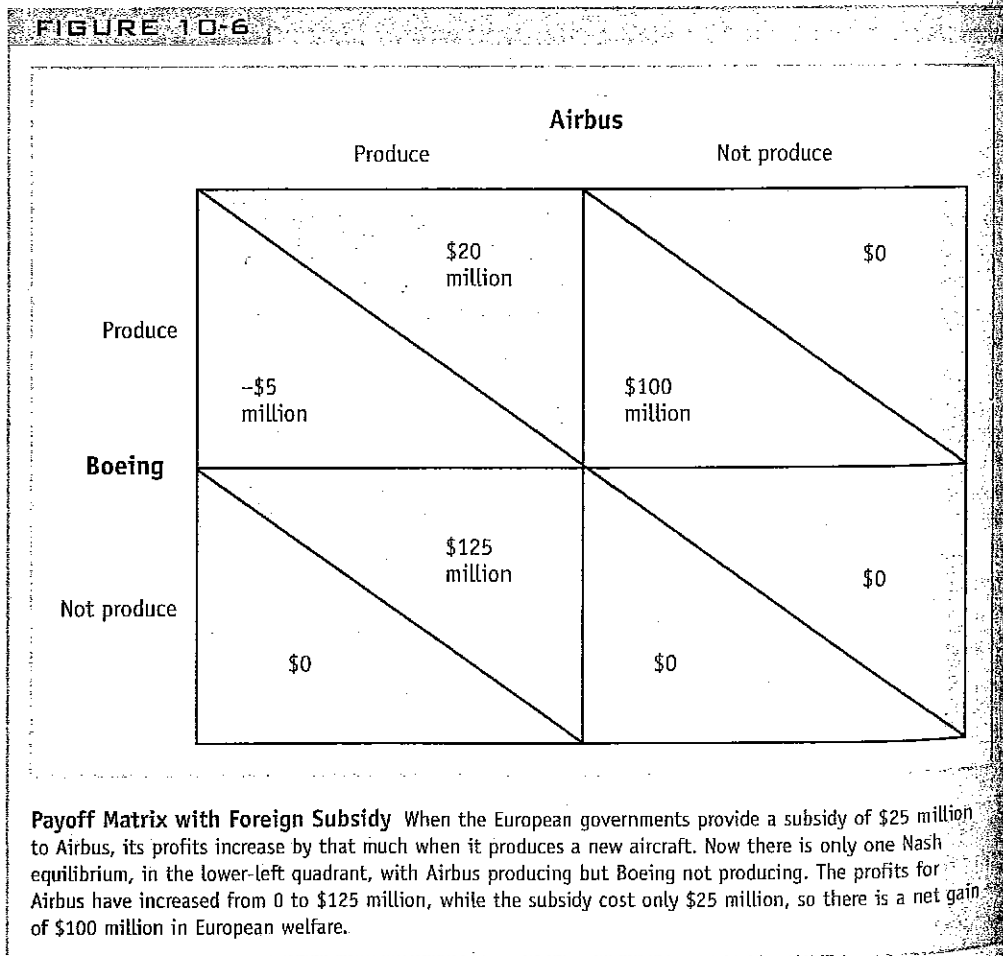
Boeing has no plans to build a production line in China, but it has still won orders to supply 150 of its 737’s to Chinese carriers. Seventy of those are firm contracts and the rest commitments. Like the A320, the 737 is a single-aisle aircraft suitable for short-haul domestic routes. Boeing has also booked orders from the Chinese for 60 of its new medium-size double-aisle plane, the 787—with parts of it to be manufactured in Japan.

For Europe, Airbus is also a potent tool to cultivate commercial ties with China. Chinese leaders and President Jacques Chirac of France have celebrated visits to each other’s capitals by signing aircraft deals.

Source: Excerpted from Mark Landler and Keith Bradsher, *New York Times*, March 15, 2006, online edition.

when it produces. In Figure 10-6, 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 are 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, 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.



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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) 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 profits:	+ 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.⁶

Subsidy with Cost Advantage for Boeing

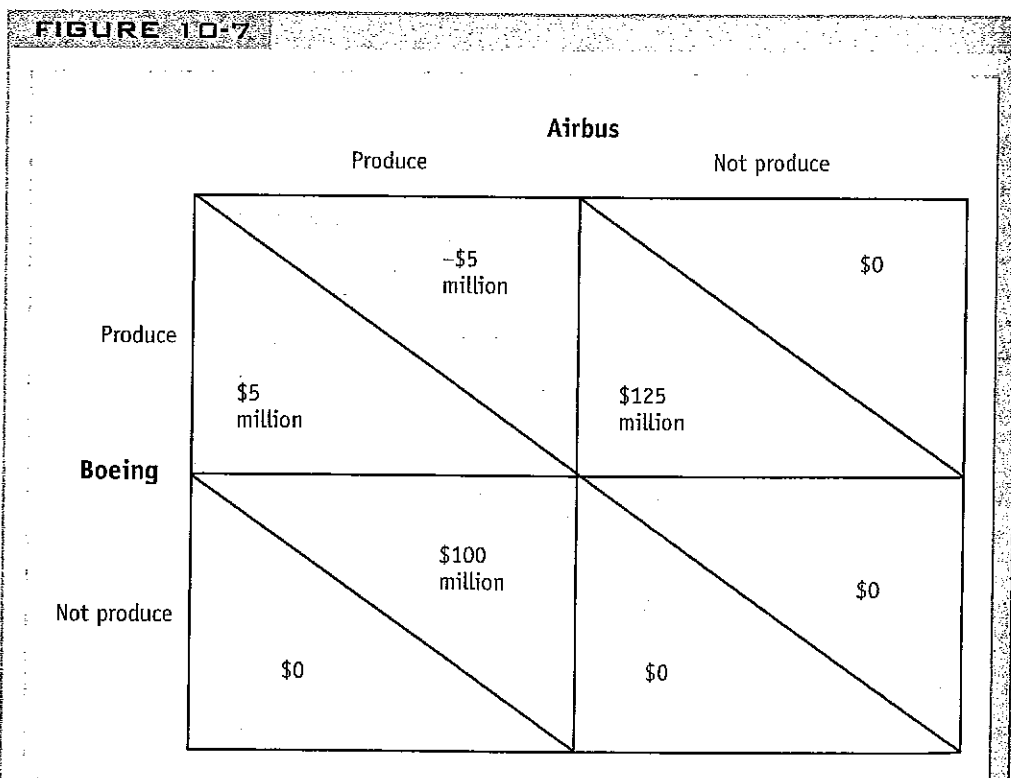
Our finding that the subsidy can raise European welfare depends on the numbers we assumed so far, however. Let us now consider another case in which

⁶ 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.

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 10-7. 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 10-5 (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 10-8.



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.

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FIGURE 10-8

		Airbus	
		Produce	Not produce
Boeing	Produce	\$5 million \$20 million	\$125 million \$0
	Not produce	\$0 \$125 million	\$0 \$0

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.

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 to not 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

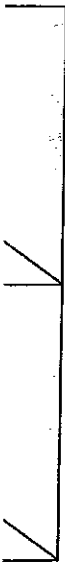
Is this new position a Nash equilibrium? Once again, we need to check to see whether, given Airbus's new post-subsidy decision to produce, Boeing is still making the right decision. Given that Airbus produces, then Boeing earns profits of \$5 million when it produces and 0 when it does not produce. Therefore,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

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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 lessons 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. While 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.

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Source: Exce

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 are being violated by Airbus as it sells a new aircraft: the double-decker

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 percent 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 percent of total development costs at the government cost of borrowing within 17 years of first disbursement; the remaining 8 percent will be repaid at the government cost of borrowing plus 1 percent 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 percent of the value of industry-wide turnover in each signatory and 4 percent 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 a 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.

HEADLINES

Airbus in a Spin as Investors Punish Delays

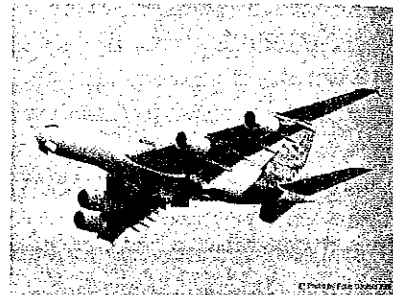
The following article describes the delays that regularly occur in the aircraft industry as firms complete new models. The A380 superjumbo from Airbus was delayed from its planned delivery date in late 2006, and instead, some customers will receive it in 2007. The maiden flight of the A380 from Europe to the United States occurred in March 2007:

Airbus' fall from grace was brutally punished by disappointed investors yesterday. The market capitalization of EADS, its parent company, fell by more than a quarter, or more than \$6.3 billion, in response to the latest delays in the production schedule for the A380 superjumbo. Recent years, when Airbus seemingly could do no wrong, seem like a distant memory, as the European aircraft maker struggles with an ever more daunting array of problems. As it battles to bring order to its production system for the A380, the biggest passenger jet ever developed, Airbus faces another tough challenge: to come up with a competitive product in the medium capacity segment of the civil aircraft market. A resurgent Boeing has been winning impressive order volumes of its 250-300 seat, long-range 787 Dreamliner, due in service in 2008, while the Airbus response, the A350, has been rejected by key customer groups as being too little, too late.

Source: Excerpted from Kevin Dome, *Financial Times*, June 15, 2006, p. 20.

... Keeping the production system in good order and making sure that the myriad suppliers of parts and systems are keeping pace with the rising stream of deliveries is itself a highly complex task. Boeing had to bring its assembly lines to a complete halt at one point in the second half of the 1990s, as it lost control of the assembly system. Problems in new aircraft development programmes are also not unique to Airbus. The first indications are surfacing too at Boeing that it is facing some technology problems and delays in the development of the 787, although the US group insists it will still meet its deadline for first deliveries in 2008. The problems for Airbus, however, have still been a rude awakening.

... Last year the whole industry surfed on a record wave of new orders, with Airbus and Boeing combined securing 2,140 gross new orders—surpassing the previous industry peak of 1,528 for aircraft of 100 seats and above, set in



The Airbus A380 superjumbo airplane leaves Frankfurt, Germany, for the United States in March 2007.

1989. EADS' operating profits last year rose by 17 percent, and the Franco-German group has forecast a further increase in profits of up to 19 percent in 2006. It said on Tuesday that the A380 delays would not lead to a change in profits guidance for this year, with the first real impact showing through in 2007 and later.

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. That means that applying an export subsidy in a large exporting country leads to even greater losses than applying 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

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KEY POINTS

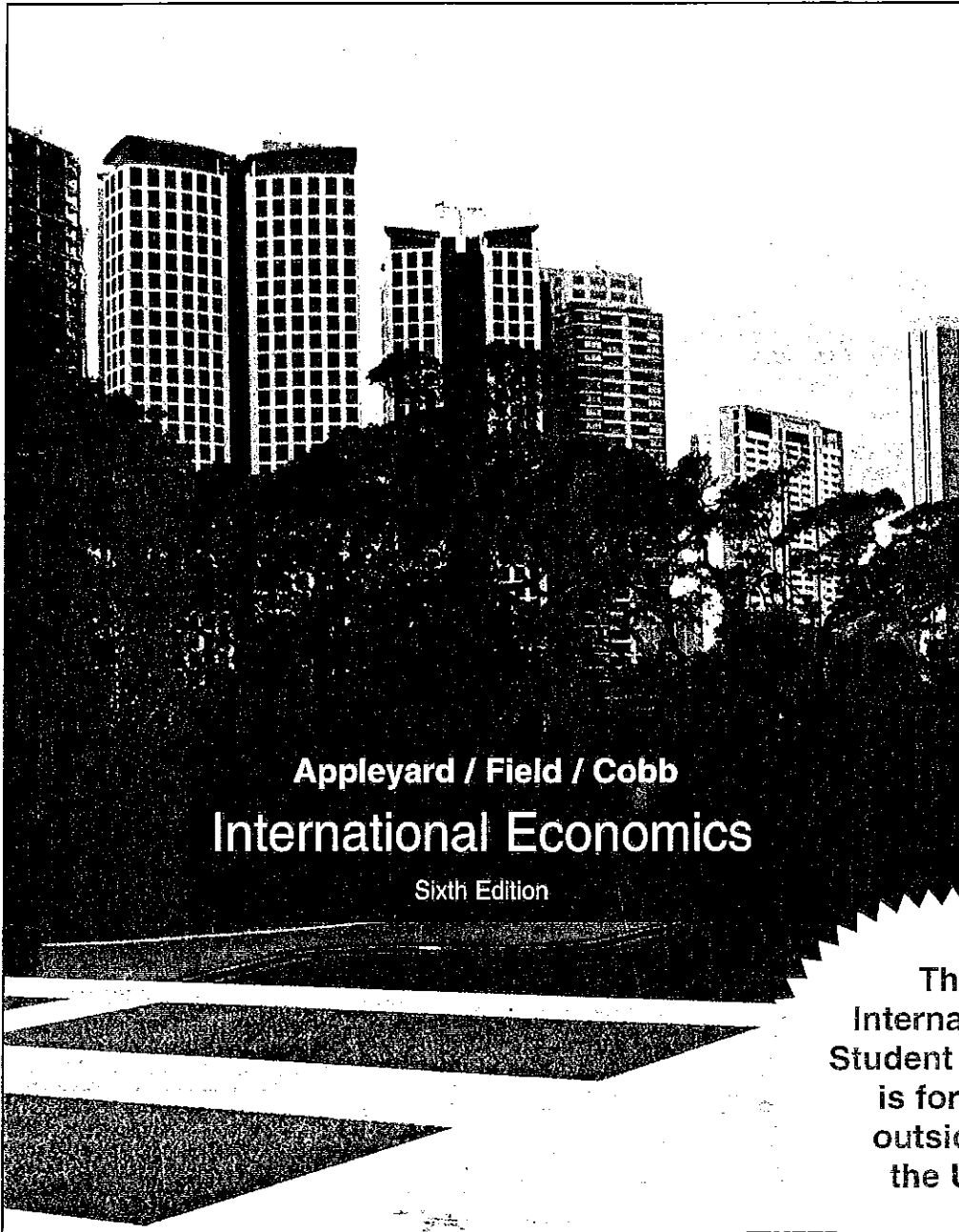
1. An export subsidy in a small country leads to a terms-of-trade loss, since the world price falls.
2. In the large country case, the loss is smaller because the world price falls less. There is a possibility of gain because the terms-of-trade loss is smaller. Therefore, a large country can gain from an export subsidy.
3. Export subsidies in a small country create a deadweight loss. Therefore, a small country has a net loss from an export subsidy.

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 made a much weaker agreement for production subsidies and other domestic farm supports.

The losses experienced by an export country due to subsidies potentially change when we consider high-technology industries. In this chapter, we have 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 have shown 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. 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 for an equal export subsidy, and the terms-of-trade loss is also smaller.
5. 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 on 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.



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provided for distortions related to foreign dumping, foreign subsidies, and apparent non-tariff barriers to trade.

Tariff to Offset Foreign Dumping

This argument, usually known as the **antidumping argument** for a tariff, has been used prominently in the United States in recent years. It is first necessary to define *dumping*. To the economist, **dumping** occurs when a firm sells its product at a lower price in the export market than in the home-country market. This definition says nothing about “selling below cost”—the popular meaning of dumping. Rather, to the economist, dumping is simply a form of price discrimination. As you recall, price discrimination occurs when a firm sells the same product in different markets at different prices.

The argument for protection is that dumping by foreign firms into the home country is in some sense unfair and constitutes a threat to domestic producers because of the low import price; therefore, a tariff can offset the foreign firm’s unfair price advantage. The argument was buttressed by the U.S. Trade Act of 1974, which added a second definition of dumping distinctly different from that used by economists. In addition to recognizing the traditional definition, the act also allowed “dumping” to be a situation in which the foreign firm is “selling below cost” or “fair value.” Given this definition, the argument indeed takes on the implication that this “unfair” behavior should be prevented through the imposition of a tariff, that is, an **antidumping duty**.

How should we assess the validity of this argument for protection? In any assessment, economists usually distinguish three types of dumping. In **persistent dumping**, the good is continually sold at a lower price in the importing country than in the home country. This situation is one in which the import good is simply being sold in different markets for different prices under profit-maximizing conditions. This is the price-discrimination phenomenon discussed at the end of Chapter 8. Any trade barrier would result in a higher price for consumers in the importing country, and the welfare effects discussed in Chapter 14 apply. (This behavior could not persist in the long run under the selling-below-cost definition because of producer losses, unless government provided a subsidy.)

However, the dumping may be not persistent but intermittent. Intermittent dumping can be of two types: **predatory dumping** and **sporadic dumping**. In predatory dumping, a foreign firm sells at a low price until home producers are driven out of the market; then the price is raised because a monopoly position has been established. Domestic firms may then be attracted back into the market, only to have the price reduced again to a low level. There is a valid argument for protection with predatory dumping because of the associated wasteful resource movements. As factors of production move in and out of the industry because of fluctuating import prices, real costs and waste are generated for society.

Sporadic dumping occurs when a foreign producer (or government) with a temporary surplus of a good exports the excess for whatever price it will command. This type of dumping may have temporary adverse effects on competing home suppliers (as in agriculture) by adding to the uncertainty of operating in the industry. This uncertainty, as well as the welfare losses from possible temporary resource movements, can be avoided by the imposition of protection, although other welfare effects (also applicable in predatory dumping) should be brought into the analysis when considering trade restrictions. However, sporadic dumping does not seem to justify protection when it is short-term.

The difficulty in practice is determining whether persistent, predatory, or sporadic dumping is occurring. No policymaker has yet been truly able to identify the immediate motivation behind dumping. The general procedure followed in the United States in response to alleged dumping is discussed in the box that follows.

IN THE REAL WORLD

ANTIDUMPING ACTIONS IN THE UNITED STATES

The first U.S. antidumping law was the Antidumping Act of 1916, which was superseded by the more-enforceable Antidumping Act of 1921. The 1921 act served as the basis for antidumping investigations by the Department of the Treasury until 1979, when the investigations were transferred from the Treasury to the Department of Commerce. Since 1979, U.S. antidumping law has been amended to make it consistent with GATT and WTO agreements. The underlying specification of illegal action incorporated into U.S. legislation is that imports are being dumped or sold at "less than fair value" when a foreign producer sells a good in the U.S. market at a price lower than the price in the foreign producer's home market, or at a price judged to be below the cost of production. The comparison with the price in the exporter's home market is replaced by a comparison in a "third country" if there aren't many sales in the producer's home market; if no "third country" market has sufficient sales, either, a value is constructed that is based on a cost-plus-profit approach. The investigation of whether or not dumping is occurring can occur only if a petition has been filed that is supported by producing firms or workers that account for at least 25 percent of the domestic import-competing industry's output, among other criteria. As indicated in the main body of this text, if dumping is determined by the Department of Commerce to have occurred and if material injury or threat of material injury to the U.S. import-competing industry is determined by the U.S. International Trade Commission (USITC) to have taken place, then an antidumping duty equal to the difference between the U.S. price and the foreign or constructed price is imposed.

At the behest of U.S. import-substitute firms, the U.S. authorities have very frequently undertaken antidumping investigations in recent years; indeed, antidumping duties are often said to be the recent "instrument of choice" of protectionists. From 1980 through 2003 (fiscal years), there were 1,058 antidumping petitions brought to the Department of Commerce/U.S. International Trade Commission. In the 1,058 cases, an affirmative finding was indicated by both Commerce and the USITC (i.e., dumping was determined to have taken place and injury or threat of injury was a consequence) in 441 instances, or 41.7 percent of the cases [(441/1,058) = 41.7 percent]. A negative finding was indicated by the USITC (i.e., no finding of injury or threat of injury occurred even though dumping had taken place) in 410 cases, or 38.8 percent of the total cases [(410/1,058) = 38.8 percent]. Finally, in the remaining 207 cases (19.6 percent of the total), the Department of Commerce terminated or

suspended the investigations or determined that dumping had not occurred (see Figure 4). Termination or suspension can occur before conclusion of the investigation in any given case if the exporters of the good to the United States agree to eliminate the dumping, to stop exporting the good to the United States, to raise the price to eliminate the dumping, or to work out some other arrangement (such as a VER) that will reduce the quantity of imports. Indeed, the mere threat of an antidumping investigation may cause foreign firms to raise their export prices and thus to cease any dumping they were practicing. Termination can also be done by Commerce (as it did with respect to a petition against imported oil in 1999) if the majority of domestic U.S. firms in the import-competing industry do not indicate agreement with the antidumping petition. In the case of a suspended agreement, the investigation can be reinstated if the dumping begins again.

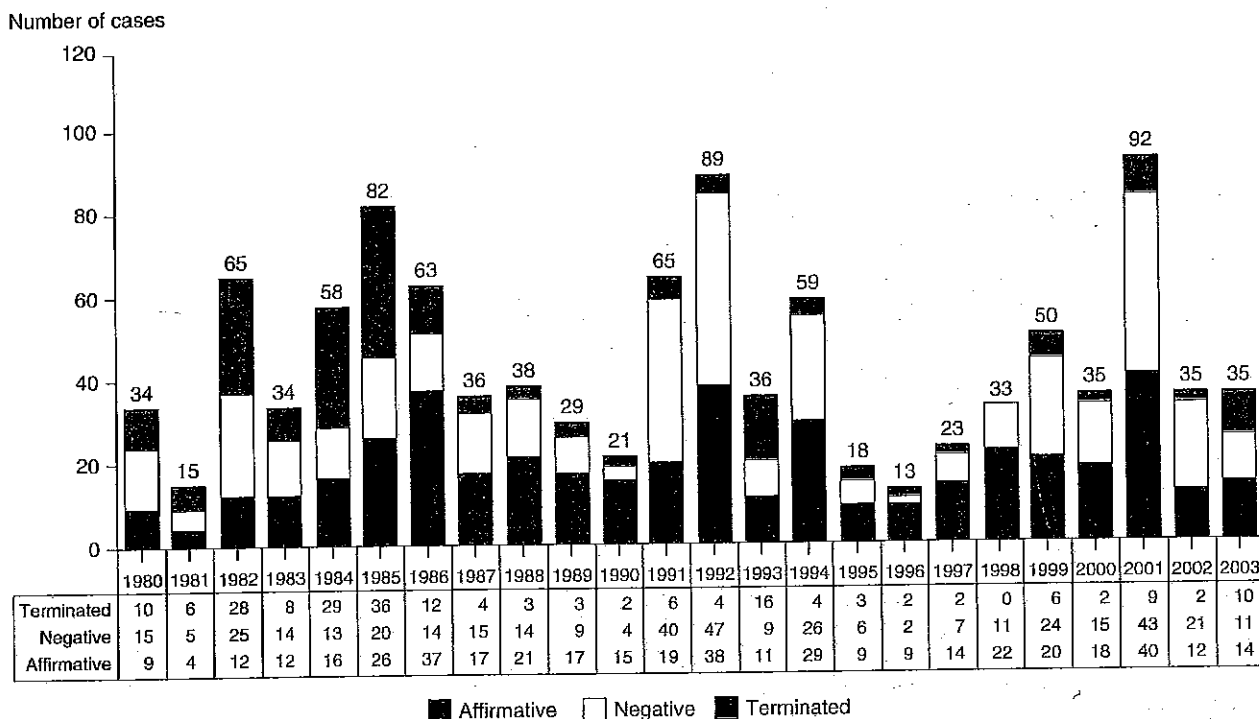
To get a feel for the frequency with which antidumping findings have been affirmative, note that, according to the USITC, there were, on February 15, 2007, 248 antidumping orders in effect on goods coming from 41 different countries. These totals reflected the cumulative number of affirmative findings still in effect since their earlier implementation. Some of the antidumping orders dated back to the 1970s. With respect to countries, China had the most antidumping orders in effect on its products (61), covering goods such as barium chloride, axes, carbon steel plate, and honey. Japan ranked second with 22 antidumping orders applied to its goods—products such as ball bearings, polyvinyl alcohol, cement, and polychloroprene rubber. Other countries with sizable numbers of antidumping orders in effect were South Korea (16), Taiwan (15), India (14), Italy (12), and Brazil (11).

An additional aspect of the antidumping scene recently has been the controversy over a 2000 U.S. congressional action, the Byrd Amendment, which permitted the funds collected from antidumping duties (as well as countervailing duties), to be channeled to the U.S. firms claiming injury from the dumping. Hence, dumping continues to be a contentious political issue.

Sources: U.S. International Trade Commission, *Antidumping and Countervailing Duty Handbook*, USITC Publication 3750 (Washington, DC: USITC, January 2005); *The Year in Trade 2005*, USITC Publication 3875 (Washington, DC: USITC, August 2006), "Antidumping and Countervailing Duty Orders in Place as of February 15, 2007, by Country"; and "Trade Remedy Investigations: Byrd Amendment," all obtained from www.usitc.gov; and "Commerce Department Rejects Oil-Dumping Inquiry," *The Wall Street Journal*, August 10, 1999, pp. A2, A6.

IN THE REAL WORLD: (continued)

FIGURE 4 Antidumping Case Summary (by number of cases), Fiscal Years 1980–2003



Source: U.S. International Trade Commission, *Antidumping and Countervailing Duty Handbook*, USITC Publication 3750 (Washington, DC: USITC, January 2005), Appendix E, obtained from www.usitc.gov.

1. Upon receipt of a petition from a domestic import-competing firm or industry, the Department of Commerce determines from price and cost data (which may be difficult to obtain) whether dumping is occurring. If so, then:
2. The U.S. International Trade Commission (USITC), an independent federal agency, determines from a study of the recent history of the industry whether this dumping has been an important source of injury to the industry. If so, then:
3. Antidumping duties are imposed on the imported good. The size of the duties is designed to offset the extent of the dumping.

Similar procedures exist in other countries that belong to the World Trade Organization (WTO).

Tariff to Offset a Foreign Subsidy

The basic point of the argument for a **tariff to offset a foreign subsidy** is that a foreign government subsidy awarded to a foreign import supplier constitutes unfair trade with the home country and that the amount of foreign subsidy should be matched by a home tariff to restore equal footing to the home and the foreign industry.

In principle, an economist should have no difficulty in supporting the imposition of a tariff to offset a foreign subsidy under certain conditions, despite the recognition that domestic consumers will pay higher prices. If the subsidy allows the foreign firm to be an exporter of the product *when the foreign country does not have a comparative advantage in this good*, then the subsidy generates a distortion from the free-trade allocation of resources. World welfare is reduced because of the distortion—although the *importing* country's welfare may rise owing to the lower consumer price—and the offsetting of the distortion by an import tariff can aid in restoring the trade pattern to a more efficient one. Note that the application of this general principle is difficult. It is not an easy task to determine whether a foreign subsidy is occurring, and many import-competing firms are quick to assert that a subsidy exists because they are being under-sold. In addition, conceptual issues surround the definition of a subsidy. For example,

IN THE REAL WORLD:

COUNTERVAILING DUTIES IN THE UNITED STATES

The first U.S. countervailing-duty (CVD) law was passed in 1897, when duties were authorized against subsidized imports of sugar. The current provisions of the law differ somewhat from the original legislation. Originally, duties were to be assessed on goods that benefited from an export subsidy, but the U.S. Congress in 1922 extended the application of the duties to subsidies on manufacture as well as subsidies on export. Also, prior to 1974, there was no injury test necessary to have CVDs imposed—a finding of the existence of the subsidy was sufficient. In addition, since 1979, the Department of Commerce has conducted the investigations on the existence of subsidies (previously done by the Department of the Treasury), and the U.S. International Trade Commission (USITC) has conducted the injury investigations (analogous to the injury investigations regarding dumping). These injury investigations are not generally required as a condition for imposing a countervailing duty if the offending country is not a member of the World Trade Organization (WTO, which has 150 members as of this writing).

As with the antidumping investigations discussed earlier, there have been a large number of industry petitions, which have to meet certain criteria to be accepted, and subsequent investigations in recent years. From 1980 to 2003, there were 452 petitions, of which 117 cases, or 25.9 percent [$(117/452) = 25.9$ percent], were decided in the affirmative. Hence, in each of these 117 cases, the Department of Commerce judged that a subsidy had been given by the exporting country's government and the USITC determined that material injury or threat of material injury had occurred. In 196 of the cases, or 43.4 percent [$(196/452) = 43.4$ percent], the

result was negative, meaning that the USITC found no injury or threat of injury even though the Department of Commerce had found that a subsidy had taken place. Finally, in the remaining 139 cases (30.8 percent), the investigation was terminated or suspended or Commerce did not find a subsidy (see Figure 5). Termination can occur if a petition is withdrawn (perhaps because some solution, such as the negotiation of a VER, is worked out). A suspension can occur if the subsidizing country or countries agree to eliminate the subsidy, to stop exporting the product to the United States, or in some way to eliminate any injurious effects on the domestic industry. If these conditions are violated, the investigation can begin again or the previously determined countervailing duty can then be imposed. It should also be noted that, in either an antidumping case or a countervailing-duty case, the foreign exporter must put up funds equal to the potential value of the duty even before the case is finally decided. If the ultimate decision is not to put on antidumping duties or countervailing duties, then these funds are refunded (but of course the foreign firm has lost the use of the funds in the meantime).

As with antidumping duties, the number of CVD orders in effect (the accumulation over the years that are still operative) gives a sense of the importance of this trade policy instrument. As of February 15, 2007, there were 35 CVDs in place against 15 countries. While not nearly as large in number as the 248 antidumping orders in effect at that time, the CVD number does indicate substantial use of the antisubsidy mechanism. The countries facing the most CVDs were India (7) and South Korea (5). There was some diversity

(continued)

the United States and Canada have been embroiled in a dispute for more than 10 years as to whether Canadian exports of softwood lumber to the United States are subsidized. The United States maintains that the stumpage fees paid by Canadian firms for the right to cut logs on government-owned land are “too low” and constitute a subsidy and unfair competition for U.S. firms cutting logs on private U.S. land. Canadians deny that their firms are subsidized.

Despite these uncertainties, the United States has a well-defined procedure, similar to the antidumping procedure, for implementing a tariff to offset a foreign subsidy. Upon receipt of a petition from a U.S. importing firm or industry, the

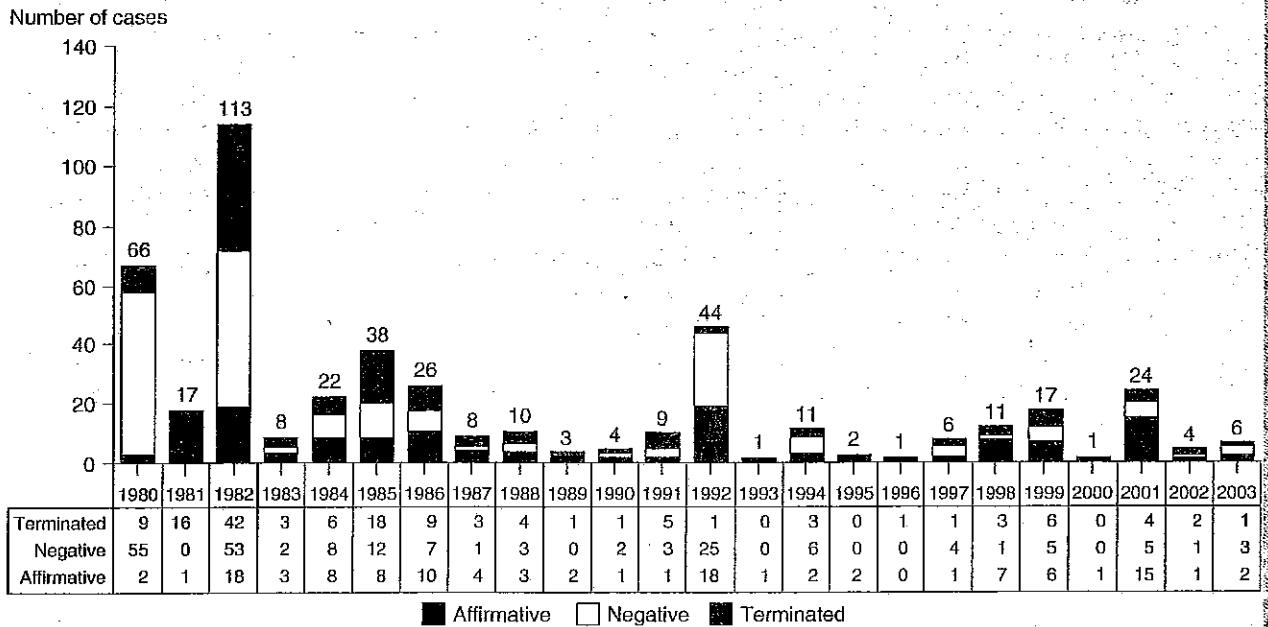
IN THE REAL WORLD: (continued)

regarding type of product (e.g., honey, pasta, softwood lumber), but there was a rather heavy concentration on iron and steel products (more than one-half of the total).

2005, USITC Publication 3875 (Washington, DC: USITC, August 2006); and “Antidumping and Countervailing Duty Orders in Place as of February 15, 2007, by Country,” all obtained from www.usitc.gov; and U.S. Trade Representative, *2007 Trade Policy Agenda and 2006 Annual Report of the President of the United States on the Trade Agreements Program* (Washington, DC: Office of the U.S. Trade Representative, 2007), obtained from www.ustr.gov.

Sources: U.S. International Trade Commission, *Antidumping and Countervailing Duty Handbook*, USITC Publication 3750 (Washington, DC: USITC, January 2005); *The Year in Trade*

FIGURE 5 Countervailing Duty Case Summary (by number of cases), Fiscal Years 1980–2003



Source: U.S. International Trade Commission, *Antidumping and Countervailing Duty Handbook*, USITC Publication 3750 (Washington, DC: USITC, January 2005), Appendix E, obtained from www.usitc.gov.

Department of Commerce determines whether or not a foreign supplier has been given a subsidy. If the answer is yes, the USITC applies the "injury test." If injury is occurring, then a **countervailing duty (CVD)** is imposed to offset the price impact of the foreign subsidy.

CONCEPT CHECK

1. Will a tariff designed to capture foreign monopoly profit necessarily increase domestic welfare in the importing country?
 2. Why do markets have to be kept separate by artificial or natural barriers for dumping to occur?
 3. How can an export subsidy by a country actually reduce world welfare?
-

MISCELLANEOUS, INVALID ARGUMENTS

Various arguments are continually encountered that, on the surface, seem logical but, upon close examination, make little sense. Several examples of these arguments are discussed briefly herein. One common argument is that a country should use protection to reduce imports and "keep the money at home." First, this is a pure Mercantilist argument that seemingly places emphasis on holdings of money as central to the decision as opposed to productivity, economic efficiency, and higher consumer well-being. Because money is of value only in its ability to be used as a claim for desired goods and services, the money that flows out of a country to acquire imports will ultimately return to the country in terms of a claim on home exports. Because trade allows both countries to get goods cheaper, the movement of money has increased the overall welfare of the countries involved, not reduced it because the money left the country in exchange for desired goods.

Another commonly heard argument argues for protection to "level the playing field" in terms of offsetting cheap foreign labor or other reasons for cost differences. In the extreme, it is often referred to as the "scientific tariff," that is, a tariff that equalizes product costs among countries. It is obvious that such distortions in the extreme take away the very basis for trade and hence the gains from trade. The view from the labor-abundant country is that the capital-abundant country has unfairly cheap capital. If both countries protect in a symmetric fashion, the cost basis for trade will be eliminated. Protection imposed to reduce competition reduces world efficiency, denies consumers the right to get goods cheaper, and limits their choice of goods. Arguments for protection based on a local producer's "right to the market" are similar in nature. In essence, this is just an argument for a consumer-to-producer transfer through higher prices, and, as in the previous case, it reduces consumer choice.

STRATEGIC TRADE POLICY: FOSTERING COMPARATIVE ADVANTAGE

The use of trade policy as part of development and/or industrial policy has been around for a long period of time. Underlying these ideas is the belief that governments can foster the development of comparative cost advantages by providing firms with access to the domestic market for a reasonably short period of time so that they have the opportunity to develop the underlying comparative cost advantage through economies of scale and improved production efficiency. One of the earliest approaches, which has endured over the years, is the now-famous infant industry argument introduced by Alexander Hamilton and Frederick List in the late 18th century. Although it was a little-used strategy earlier on,

it became much more popular during the 20th century, particularly in Latin America. This section begins with a discussion of this still-present argument and then moves on to some of the newer theories for protection, often referred to as **strategic trade policy** theories, which suggest how a country can benefit over time from the active use of trade policy instruments, usually at the expense of trading partners. A distinguishing feature of the approach in these more recent theories is that **imperfect competition** exists in the industries under consideration—a departure from the competitive industries commonly employed in traditional trade analysis. Other critical elements of this approach include recognized interdependence of firms in a given industry and the presence of **economies of scale**. Within this framework it can be demonstrated that policies that seek to expand exports or reduce imports can potentially lead to the realization of dynamic, long-run cost advantage. In the latter part of this section, we summarize several of these new theories to provide an insight as to how trade policy might, in fact, be used to foster dynamic comparative advantages.

The Infant Industry Argument for Protection

Economists generally agree that this long-standing argument for protection is valid from the standpoint of enhancing the welfare of the world as a whole. The **infant industry argument** rests on the notion that a particular industry in a country may possess, for various reasons, a long-run comparative advantage even though the country is an importer of the good at the present time. Suppose that the growth of the industry in a country is inhibited by low-cost imports from a foreign country. Production in the foreign country may be occurring because of historical accident, and the home-country industry is getting a “late start.” If protection could temporarily be given to the industry in the home country, the argument goes that firms in this industry will be able to achieve a reduction in unit costs through realizing economies of scale or through learning by doing. The economies of scale could be internal to firms, which are now each producing a larger volume of output; that is, producers in the home country will be moving down their downward-sloping long-run average cost curves. Or the knowledge acquired by producing the good could lead workers and managers to devise more cost-efficient methods, which would shift cost curves downward. Or the economies could be external to the firm but internal to the industry, in which case greater industry output would reduce costs for the individual firm due, for instance, to the attraction of a pool of skilled labor to an area. In any event, per-unit costs eventually fall to such an extent that the industry in the home country becomes an exporter of the good. At this point, protection can be removed as it is no longer needed. The home industry has a comparative advantage that it cannot realize in the short run but can in the long run if temporary protection is imposed. The consumers of the home country are asked to finance the long-run expansion of the industry, but they will be more than “repaid” when the industry “grows up.” Indeed, with a new comparative-advantage producer in the world market, the world as a whole benefits.

In practice, the infant industry argument is put forth more frequently in developing countries than in developed countries. Developing countries often propound the argument in the context of an import-substitution program, whereby reliance on the world market for a good is to be replaced by home production, whether or not export potential is envisioned. This application of the infant industry argument is a variant of the traditional version, but it can be evaluated on similar grounds.

What are we to make of the infant industry argument? Even though economists generally agree that it is theoretically valid, not every industry that claims to be an infant should automatically be granted protection. The difficulty in making this argument operational centers around the identification of industries that are likely to become low-cost producers.

If an industry protected by this argument is not a true infant, then the country (and the world) may be saddled with permanent protection of a high-cost industry and less efficient resource use. This was noted long ago by American economist Henry George, who wrote (1911, p. 97, originally 1886), "Nothing could better show the futility of attempting to make industries self-supporting by tariff than the confessed inability of the industries that we have so long encouraged to stand alone."

IN THE REAL WORLD:

U.S. MOTORCYCLES—A SUCCESSFUL INFANT INDUSTRY?

A modern variant of the infant industry argument is found in U.S. motorcycle production. The industry itself is hardly an infant since the first motorcycle was manufactured commercially in the United States in 1901, and there have been about 150 U.S. producers since then. By 1978, however, largely because of imports, Harley-Davidson was the *only* remaining U.S.-owned producer.

Until the early 1980s, Harley-Davidson had produced mostly heavyweight motorcycles with a piston displacement of more than 1,000 cubic centimeters. Imports were of smaller displacement and were rapidly increasing their market share. Harley-Davidson petitioned the U.S. International Trade Commission (USITC) for import relief in 1982. A USITC investigation found that imports were a substantial cause of injury to Harley-Davidson, and in 1983, higher tariff rates were imposed for a five-year period on imports above already existing quota levels. One reason that the USITC granted the increased protection was that Harley-Davidson planned to improve its efficiency and introduce a new line of smaller motorcycles (800 to 1,000 cubic centimeters); the USITC wanted to give the firm an opportunity to implement these plans. It is in the context of a new line of production (the smaller cycles) that the Harley-Davidson case has infant industry characteristics.

After the new tariffs were imposed, the import share in the U.S. motorcycle market fell from 60 to 70 percent in the early 1980s to 31 percent by 1984. In response, Japanese companies Kawasaki and Honda increased their production within the United States. Harley-Davidson itself changed management strategy, reduced costs, and improved quality. Domestic production increased, but the estimated cost to U.S. consumers (Hufbauer, Berliner, and Elliott 1986, p. 268) was \$400 to \$600 per motorcycle and, in 1984, \$150,000 per job saved in the motorcycle industry. Nevertheless, employment and output increased in the mid-1980s, and Harley-Davidson's share of the domestic market rose.* The value of shipments from U.S.-based firms has been estimated to have risen by 75

percent in real terms from 1987 to 1993, importantly due to the popularity of the cycle with engine capacity above 700 cubic centimeters and to perceived greater safety in motorcycles. In addition, exports from the United States increased at an annual rate of 37 percent from 1987 to 1991, although this growth slowed thereafter. Some of the increase in exports was also attributed to the falling dollar, especially against the yen. Exports of motorcycles and parts continued to grow at about a 12 percent annual rate from 2000 to 2005. Harley-Davidson continued to be profitable in the 1990s and into the new century. As an example, a share of Harley-Davidson common stock bought in March 1997 for \$35.00 split twice and was worth more than \$240 in March 2007.

How does the motorcycle industry fit the infant industry argument? A domestic firm had sought temporary protection with the hope of gaining time to move into a new product. The temporary protection was granted, the firm expanded production, and eventually it became an exporter. The consumer cost was high, however, and some of the export performance was perhaps due to other factors (the exchange rate, improved safety perceptions).

*In fact, Harley-Davidson in 1987 concluded that it was then able to compete with the Japanese and asked for removal of the higher tariffs one year ahead of schedule.

Sources: "Harley Asks TTC to End Tariffs Firm Sought in '83," *The Wall Street Journal*, March 18, 1987, p. 46; Gary Clyde Hufbauer, Diane T. Berliner, and Kimberly Ann Elliott, *Trade Protection in the United States: 31 Case Studies* (Washington, DC: Institute for International Economics, 1986), pp. 263-69; "Reagan Rebuffs Trade Bill in Motorcycle-Plant Tour," *The Wall Street Journal*, May 7, 1987, p. 6; U.S. Department of Commerce, *U.S. Industrial Outlook 1990*, pp. 40-10 and 40-11; U.S. Department of Commerce, *U.S. Industrial Outlook 1993*, pp. 37-7 and 37-8; U.S. Department of Commerce, *U.S. Industrial Outlook 1994*, p. 37-9; International Trade Administration of the U.S. Department of Commerce, "Top 20 U.S. Export Destinations for Motorcycles and Parts," obtained from www.ita.doc.gov.

A century later, Gerald Meier (1987) reviewed empirical evidence on the infant industry argument in developing countries. He noted (p. 830) that Krueger and Tuncer (1982) concluded that Turkey's protected industries did not experience decreasing costs more than less protected industries did; further, the protected industries might well have grown without the protection. Martin Bell, Bruce Ross-Larson, and Larry Westphal (1984, p. 114) found that few protected firms in a number of developing countries increased productivity sufficiently to attain international competitiveness. Meier also cites the point by Westphal (1981, p. 12) that the initial costs in terms of domestic resources for infant industry protection in developing countries might be twice the amount of foreign exchange saved or earned by the protection.

Beyond the problem of identification, the economist should also ask whether the tariff or another form of protection is the relevant policy—even if the industry is a qualifying infant. For example, a case might be made, for attaining both internal and external economies and stimulating learning by doing, that a subsidy to the industry by the home-country government is superior to a tariff. As noted in Chapter 14, a subsidy has a lower welfare cost to the country than a tariff. A subsidy also comes up for reevaluation every year when a government authorizes expenditure, so its benefits and costs are analyzed more frequently than is possible with a tariff, which is placed in the schedules and does not need to be brought up for annual review.

More fundamentally, however, the economist asks why the industry in the country is unable to proceed on its own and why it needs protection. If internal economies of scale and/or learning by doing could be realized from expansion, entrepreneurs in a market economy presumably know this and would undertake expansion on their own. They would borrow funds from financial institutions, invest in plant expansion, and use the profits from the new dominance in the market to repay the loans. (However, this entrepreneurial expansion would not necessarily occur in the case of external economies of scale.) If this process does not get under way on its own, capital markets are probably operating inefficiently in allocating funds. Therefore, a proper focus of policy should be on taking measures to improve the operation of capital markets, perhaps through deregulation or government guarantees for the loans. The focus on the capital market as the culprit is especially relevant for developing countries, because their financial institutions are often cited as biased toward making short-term rather than long-term loans. An important cause of this bias in developing countries may be the uncertainty surrounding the repayment of long-term loans.

Economies of Scale in a Duopoly Framework

An important contribution to the strategic trade policy literature came from economist Paul Krugman (1984). In his model, Krugman assumes there are two firms in an industry, a **duopoly** (a home firm and a foreign firm), that compete with each other in markets throughout the world (including in each other's markets). Krugman's intention is to demonstrate how import protection for one firm leads to an increase in *exports* for the protected firm in any foreign market in which that firm operates. Two assumptions are particularly critical: (1) Marginal cost declines with an increase in output—that is, economies of scale are associated with producing output; and (2) each firm takes the actions of the other firm into account when making its own price and output decisions. The last point means, for example, that the home firm perceives that its revenue depends positively on its own output but negatively on the foreign firm's output. This **recognized interdependence** does not exist in a perfectly competitive model.

With recognized interdependence, we can conceive of **reaction functions** for each firm in each market (see Figure 6). The symbol X_i on the horizontal axis refers to the sales of the home firm in any market i , while X_i^* on the vertical axis refers to the sales of the foreign firm in the same market. HH is the reaction function for the home firm. The reasoning



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competition. The increased competition represents a benefit that may offset the waste of resources in transportation. The net effect of such peculiar trade on a nation's economic welfare is therefore uncertain.

The Theory of External Economies

In the monopolistic competition model of trade, it is presumed that the economies of scale that give rise to international trade occur at the level of the individual firm. That is, the larger any particular firm's output of a product, the lower its average cost. The inevitable result of such economies of scale at the level of the firm is imperfect competition, which in turn allows such practices as dumping.

As we pointed out early in this chapter, however, not all scale economies apply at the level of the individual firm. For a variety of reasons, it is often the case that concentrating production of an industry in one or a few locations reduces the industry's costs, even if the individual firms in the industry remain small. When economies of scale apply at the level of the industry rather than at the level of the individual firm, they are called *external economies*. The analysis of external economies goes back more than a century to the British economist Alfred Marshall, who was struck by the phenomenon of "industrial districts"—geographical concentrations of industry that could not be easily explained by natural resources. In Marshall's time, the most famous examples included such concentrations of industry as the cluster of cutlery manufacturers in Sheffield and the cluster of hosiery firms in Northampton. Modern examples of industries where there seem to be powerful external economies include the semiconductor industry, concentrated in California's famous Silicon Valley; the investment banking industry, concentrated in New York; and the entertainment industry, concentrated in Hollywood.

Marshall argued that there were three main reasons why a cluster of firms may be more efficient than an individual firm in isolation: the ability of a cluster to support **specialized suppliers**; the way that a geographically concentrated industry allows **labor market pooling**; and the way that a geographically concentrated industry helps foster **knowledge spillovers**. These same factors continue to be valid today.

Specialized Suppliers

In many industries, the production of goods and services—and to an even greater extent, the development of new products—requires the use of specialized equipment or support services; yet an individual company does not provide a large enough market for these services to keep the suppliers in business. A localized industrial cluster can solve this problem by bringing together many firms that collectively provide a large enough market to support a wide range of specialized suppliers. This phenomenon has been extensively documented in Silicon Valley: A 1994 study recounts how, as the local industry grew, "engineers left established semiconductor companies to start firms that manufactured capital goods such as diffusion ovens, step-and-repeat cameras, and testers, and materials and components such as photomasks, testing jigs, and specialized chemicals. . . . This independent equipment sector promoted the continuing formation of semiconductor firms by freeing individual producers from the expense of developing capital equipment internally and by spreading the costs of development. It also reinforced the tendency toward industrial localization, as most of these specialized inputs were not available elsewhere in the country."¹¹

¹¹ See the book listed in Further Reading by Saxenian, p. 40.

As the quote suggests, the availability of this dense network of specialized suppliers has given high-technology firms in Silicon Valley some considerable advantages over firms elsewhere. Key inputs are cheaper and more easily available because there are many firms competing to provide them, and firms can concentrate on what they do best, contracting out other aspects of their business. For example, some Silicon Valley firms that specialize in providing highly sophisticated computer chips for particular customers have chosen to become “fabless,” that is, they do not have any factories in which chips can be fabricated. Instead, they concentrate on designing the chips, then hire another firm actually to fabricate them.

A company that tried to enter the industry in another location—for example, in a country that did not have a comparable industrial cluster—would be at an immediate disadvantage because it would lack easy access to Silicon Valley’s suppliers and would either have to provide them for itself or be faced with the task of trying to deal with Silicon Valley-based suppliers at long distance.

Labor Market Pooling

A second source of external economies is the way that a cluster of firms can create a pooled market for workers with highly specialized skills. Such a pooled market is to the advantage of both the producers and the workers as the producers are less likely to suffer from labor shortages, while the workers are less likely to become unemployed.

The point can best be made with a simplified example. Imagine that there are two companies that both use the same kind of specialized labor, say, two film studios that make use of experts in computer animation. Both employers are, however, uncertain about how many workers they will want to hire: If demand for its product is high, both companies will want to hire 150 workers, but if it is low, they will only want to hire 50. Suppose also that there are 200 workers with this special skill. Now compare two situations: one with both firms and all 200 workers in the same city, the other with the firms and 100 workers in two different cities. It is straightforward to show that both the workers and their employers are better off if everyone is in the same place.

First, consider the situation from the point of view of the companies. If they are in different locations, whenever one of the companies is doing well it will be confronted with a labor shortage; it will want to hire 150 workers, but only 100 will be available. If the firms are near each other, however, it is at least possible that one will be doing well when the other is doing badly, so that both firms may be able to hire as many workers as they want. So by locating near each other, the companies increase the likelihood that they will be able to take advantage of business opportunities.

From the workers’ point of view, having the industry concentrated in one location is also an advantage. If the industry is divided between two cities, then whenever one of the firms has a low demand for workers the result will be unemployment; the firm will be willing to hire only 50 of the 100 workers who live nearby. But if the industry is concentrated in a single city, low labor demand from one firm will at least sometimes be offset by high demand from the other. As a result, workers will have a lower risk of unemployment.

Again, these advantages have been documented for Silicon Valley, where it is common both for companies to expand rapidly and for workers to change employers. The same study of Silicon Valley that was quoted previously notes that the concentration of firms in a single location makes it easy to switch employers, quoting one engineer as saying that “it wasn’t that big a catastrophe to quit your job on Friday and have another job on Monday. . . . You didn’t even necessarily have to tell your wife. You

just drove off in another direction on Monday morning."¹² This flexibility makes Silicon Valley an attractive location both for highly skilled workers and for the companies that employ them.

Knowledge Spillovers

It is by now a cliché that in the modern economy knowledge is at least as important an input as factors of production like labor, capital, and raw materials. This is especially true in highly innovative industries, where being only a few months behind the cutting edge in production techniques or product design can put a company at a major disadvantage.

But where does the specialized knowledge that is crucial to success in innovative industries come from? Companies can acquire technology through their own research and development efforts. They can also try to learn from competitors by studying their products and, in some cases, taking them apart to "reverse engineer" their design and manufacture. An important source of technical know-how, however, is the informal exchange of information and ideas that takes place at a personal level. And this kind of informal diffusion of knowledge often seems to take place most effectively when an industry is concentrated in a fairly small area, so that employees of different companies mix socially and talk freely about technical issues.

Marshall described this process memorably when he wrote that in a district with many firms in the same industry, "The mysteries of the trade become no mystery, but are as it were in the air. . . . Good work is rightly appreciated, inventions and improvements in machinery, in processes and the general organization of the business have their merits promptly discussed: If one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of further new ideas."¹³

A journalist described how these knowledge spillovers worked during the rise of Silicon Valley (and also gave an excellent sense of the amount of specialized knowledge involved in the industry) as follows: "Every year there was some place, the Wagon Wheel, Chez Yvonne, Rickey's, the Roundhouse, where members of this esoteric fraternity, the young men and women of the semiconductor industry, would head after work to have a drink and gossip and trade war stories about phase jitters, phantom circuits, bubble memories, pulse trains, bounceless contacts, burst modes, leapfrog tests, p-n junctions, sleeping sickness modes, slow-death episodes, RAMs, NAKs, MOSes, PCMs, PROMs, PROM blowers, PROM blasters, and teramagnitudes. . . ."¹⁴ This kind of informal information flow means that it is easier for companies in the Silicon Valley area to stay near the technological frontier than it is for companies elsewhere; indeed, many multinational firms have established research centers and even factories in Silicon Valley simply in order to keep up with the latest technology.

External Economies and Increasing Returns

A geographically concentrated industry is able to support specialized suppliers, provide a pooled labor market, and facilitate knowledge spillovers in a way that a geographically dispersed industry cannot. But a country cannot have a large concentration of firms in an industry unless it possesses a large industry. Thus the theory of external economies indicates that when these external economies are important, a country with a large industry

¹²Saxenian, p. 35.

¹³Alfred Marshall, *Principles of Economics* (London: MacMillan, 1920).

¹⁴Tom Wolfe, quoted in Saxenian, p. 33.

will, other things being equal, be more efficient in that industry than a country with a small industry. Or to put it differently, external economies can give rise to increasing returns to scale *at the level of the national industry*.

While the details of external economies in practice are often quite subtle and complex (as the example of Silicon Valley shows), it can be useful to abstract from the details and represent external economies simply by assuming that an industry's costs are lower, the larger the industry. If we ignore possible imperfections in competition, this means that the industry will have a **forward-falling supply curve**: The larger the industry's output, the lower the price at which firms are willing to sell their output.

External Economies and International Trade

External economies, like economies of scale that are internal to firms, play an important role in international trade, but they may be quite different in their effects. In particular, external economies can cause countries to get "locked in" to undesirable patterns of specialization and can even lead to losses from international trade.

External Economies and the Pattern of Trade

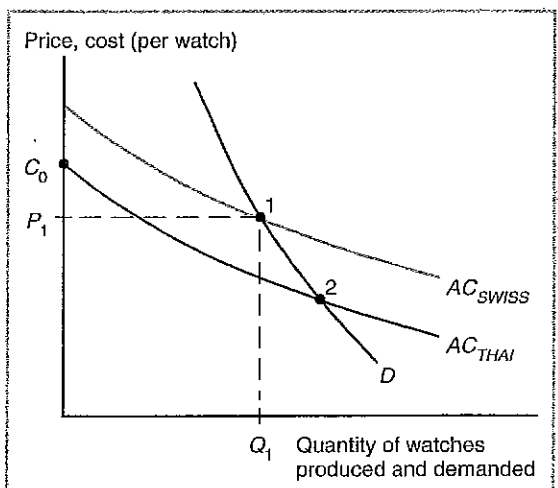
When there are external economies of scale, a country that has large production in some industry will tend, other things equal, to have low costs of producing that good. This gives rise to an obvious circularity, since a country that can produce a good cheaply will also therefore tend to produce a lot of that good. Strong external economies tend to confirm existing patterns of interindustry trade, whatever their original sources: Countries that start out as large producers in certain industries, for whatever reason, tend to remain large producers. They may do so even if some other country could potentially produce the goods more cheaply.

Figure 6-9 illustrates this point. We show the cost of producing a watch as a function of the number of watches produced annually. Two countries are shown: "Switzerland" and "Thailand." The Swiss cost of producing a watch is shown as AC_{SWISS} ; the Thai cost as

Figure 6-9

External Economies and Specialization

The average cost curve for Thailand, AC_{THAI} lies below the average cost curve for Switzerland, AC_{SWISS} . Thus Thailand could potentially supply the world market more cheaply than Switzerland. If the Swiss industry gets established first, however, it may be able to sell watches at the price P_1 which is below the cost C_0 that an individual Thai firm would face if it began production on its own. So a pattern of specialization established by historical accident may persist even when new producers could potentially have lower costs.



AC_{THAI} . D represents the world demand for watches, which we assume can be satisfied either by Switzerland or by Thailand.

Suppose that the economies of scale in watch production are entirely external to firms, and that since there are no economies of scale at the level of the firm the watch industry in each country consists of many small perfectly competitive firms. Competition therefore drives the price of watches down to its average cost.

We assume that the Thai cost curve lies below the Swiss curve, say because Thai wages are lower than Swiss. This means that at any given level of production, Thailand could manufacture watches more cheaply than Switzerland. One might hope that this would always imply that Thailand will in fact supply the world market. Unfortunately, this need not be the case. Suppose that Switzerland, for historical reasons, establishes its watch industry first. Then initially world watch equilibrium will be established at point 1 in Figure 6-9, with Swiss production of Q_1 units per year and a price of P_1 . Now introduce the possibility of Thai production. If Thailand could take over the world market, the equilibrium would move to point 2. However, if there is no initial Thai production ($Q = 0$) any individual Thai firm considering manufacture of watches will face a cost of production of C_0 . As we have drawn it, this cost is above the price at which the established Swiss industry can produce watches. So although the Thai industry could potentially make watches more cheaply than Switzerland, Switzerland's head start enables it to hold on to the industry.

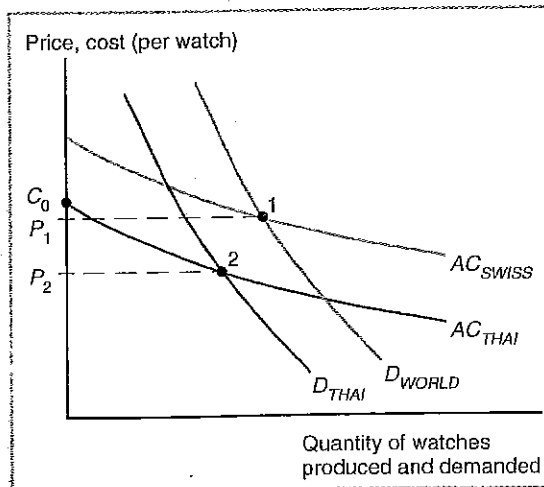
As this example shows, external economies potentially give a strong role to historical accident in determining who produces what, and may allow established patterns of specialization to persist even when they run counter to comparative advantage.

Trade and Welfare with External Economies

Trade based on external economies has more ambiguous effects on national welfare than either trade based on comparative advantage or trade based on economies of scale at the level of the firm. There may be gains to the world economy from concentrating production in particular industries to realize external economies. On the other hand, there is no guarantee that the right country will produce a good subject to external economies, and it is possible that trade based on external economies may actually leave a country worse off than it would have been in the absence of trade.

Figure 6-10
External Economies and Losses from Trade

When there are external economies, trade can potentially leave a country worse off than it would be in the absence of trade. In this example, Thailand imports watches from Switzerland, which is able to supply the world market (D_{WORLD}) at a price (P_1) low enough to block entry by Thai producers who must initially produce the watches at cost C_0 . Yet if Thailand were to block all trade in watches, it would be able to supply its domestic market (D_{THAI}) at the lower price P_2 .



An example of how a country can actually be worse off with trade than without is shown in Figure 6-10. In this example, as before, we imagine that Thailand and Switzerland could both manufacture watches, that Thailand could make them more cheaply, but that Switzerland has gotten there first. D_{WORLD} is the world demand for watches, and, given that Switzerland produces the watches, the equilibrium is at point 1. However, we now add to the figure the Thai demand for watches, D_{THAI} . If no trade in watches were allowed and Thailand were forced to be self-sufficient, then the Thai equilibrium would be at point 2. Because of its lower average cost curve, the price of Thai-made watches at point 2, P_2 , is actually lower than the price of Swiss-made watches at point 1, P_1 .

We have shown a situation in which the price of a good that Thailand imports would actually be lower if there were no trade and the country were forced to produce the good for itself. Clearly in this situation trade leaves the country worse off than it would be in the absence of trade.

There is an incentive in this case for Thailand to protect its potential watch industry from foreign competition. Before concluding that this justifies protectionism, however, we should note that in practice identifying cases like that in Figure 6-10 is far from easy. Indeed, as we will emphasize in Chapters 10 and 11, the difficulty of identifying external economies in practice is one of the main arguments against activist government policies toward trade.

It is also worth pointing out that while external economies can sometimes lead to disadvantageous patterns of specialization and trade, it is still to the benefit of the *world* economy to take advantage of the gains from concentrating industries. Canada might be better off if Silicon Valley were near Toronto instead of San Francisco; Germany might be better off if the City (London's financial district, which, along with Wall Street, dominates world financial markets) could be moved to Frankfurt. The world as a whole is, however, more efficient and thus richer because international trade allows nations to specialize in different industries and thus reap the gains from external economies as well as the gains from comparative advantage.

Dynamic Increasing Returns

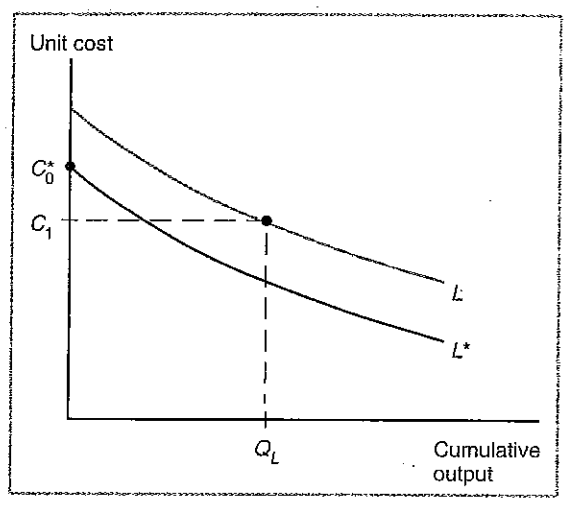
Some of the most important external economies probably arise from the accumulation of knowledge. When an individual firm improves its products or production techniques through experience, other firms are likely to imitate the firm and benefit from its knowledge. This spillover of knowledge gives rise to a situation in which the production costs of individual firms fall as the industry as a whole accumulates experience.

Notice that external economies arising from the accumulation of knowledge differ somewhat from the external economies considered so far, in which industry costs depend on current output. In this alternative situation industry costs depend on experience, usually measured by the cumulative output of the industry to date. For example, the cost of producing a ton of steel might depend negatively on the total number of tons of steel produced by a country since the industry began. This kind of relationship is often summarized by a **learning curve** that relates unit cost to cumulative output. Such learning curves are illustrated in Figure 6-11. They are downward sloping because of the effect of the experience gained through production on costs. When costs fall with cumulative production over time, rather than with the current rate of production, this is referred to as a case of **dynamic increasing returns**.

Like ordinary external economies, dynamic external economies can lock in an initial advantage or head start in an industry. In Figure 6-11, the learning curve L is that of a country that pioneered an industry, while L^* is that of another country that has lower input

Figure 6-11
The Learning Curve

The learning curve shows that unit cost is lower the greater the cumulative output of a country's industry to date. A country that has extensive experience in an industry (L) may have lower unit cost than another country with little or no experience, even if the second country's learning curve (L^*) is lower, for example, because of lower wages.



costs—say, lower wages—but less production experience. Provided that the first country has a sufficiently large head start, the potentially lower costs of the second country may not allow it to enter the market. For example, suppose the first country has a cumulative output of Q_L units, giving it a unit cost of C_1 while the second country has never produced the good. Then the second country will have an initial start-up cost C_0^* that is higher than the current unit cost, C_1 , of the established industry.

Dynamic scale economics, like external economics at a point in time, potentially justify protectionism. Suppose that a country could have low enough costs to produce a good for export if it had more production experience, but that given the current lack of experience the good cannot be produced competitively. Such a country might increase its long-term welfare either by encouraging the production of the good by a subsidy or by protecting it from foreign competition until the industry could stand on its own feet. The argument for temporary protection of industries to enable them to gain experience is known as the **infant industry argument** and has played an important role in debates over the role of trade policy in economic development. We will discuss the infant industry argument at greater length in Chapter 10, but for now we simply note that situations like that illustrated in Figure 6-11 are just as hard to identify in practice as in those involving nondynamic increasing returns.

Interregional Trade and Economic Geography

External economies play an important role in shaping the pattern of international trade, but they are even more decisive in shaping the pattern of **interregional trade**—trade that takes place between regions *within* countries.

To understand the role of external economies in interregional trade, we first need to discuss the nature of regional economics—that is, how the economies of regions within a nation fit into the national economy. Studies of the location of U.S. industries suggest that more than 60 percent of U.S. workers are employed by industries whose output is nontradable even within the United States—that is, which must be supplied locally. Table 6-4 shows some examples of tradable and nontradable industries. Thus, motion pictures made in Hollywood are shown across the country, and indeed around the world, but newspapers are mainly read in their home cities. Wall Street trades stocks and makes deals for clients