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11 High-Tech Trade Policy

Kala Krishna

11.1 Introduction

With some 90 nations about to embark on a new round of multilateral trade negotiations under GATT (General Agreement on Tariffs and Trade), there is concern that rules for "high-tech" industries be high on the agenda. The United States has been the leader in expressing this view because it perceives that the products of its high-tech industries will have (or could have) a long-run comparative advantage. Aho and Aronson (1985, 44) point out that "[t]he United States pushed for work on high technology at the 1982 GATT Ministerial Meeting, but did not convince other countries that high-technology industries should be handled any differently from other industries." In fact, they say that "the initiative was so poorly defined that LDC (less-developed countries) representatives asked how high-technology discussions could be related to transfer of technology, which is a legitimate question but not what the United States had in mind." More recently, in March 1984, the U.S. government officially called for new GATT negotiations in the area of high-tech goods. The United States informed the GATT Council meeting at that time that it would begin bilateral trade talks on high-tech goods with interested delegations. These were to be the basis for future council discussions. Other countries, however, questioned the urgency of these negotiations.

Why is it useful to think of high-tech trade separately, and why has the interest in trade policy for these industries been on the upswing? The two questions are closely related. There are two reasons for this

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increase in interest. First, trade in these products has been a growing part of total trade. Second, a number of high-tech industries possess certain characteristics that provide opportunities for currently *legal* (under GATT rules) and profitable unilateral trade policy that could be harmful to all parties in the international arena if practiced by all parties. In other words, these characteristics make the industries "fall between the cracks" of trading arrangements that are meant to prevent such suboptimal situations from arising. The importance of high-tech trade and the sector's special characteristics indicate that policy for this sector should be thought of separately and its special characteristics taken into account.

US-EC trade currently totals about $108 billion a year. A breakdown of the leading items exported to and imported from the European Community can be found in the tables of the USITC publication "Operations of the Trade Agreements Program," 37th Report, reproduced at the end of this paper as tables 11.1 and 11.2.

It remains to identify the characteristics that make some high-tech industries special. The first characteristic is that network externalities play a significant role in determining the demand for the products of these industries. Network externalities are said to exist when the utility that a user derives from consuming a good and the user's willingness to pay for a good increase with the number of people who also consume the good or are expected to do so. These externalities arise in a number of ways, both directly and indirectly. In communications equipment, such as telephones, they arise directly. People derive a greater benefit from a phone if all the people they wish to communicate with also possess a phone. They may arise indirectly, for example, if the amount of software produced is related to the number of computers in use, so that increases in the number of computers would increase the available stock of software which in turn would raise peoples' willingness to pay for a computer.

Such network externalities arise for many products that are not "high-tech"—for example, they arise for many durable goods since the availability of servicing for any durable good is likely to be related to the number of units of the good already sold in the market.[1] The network externalities are especially important, however, in such key high-tech industries as computers and telecommunications systems. In part, this is because these and a number of other high-tech goods are information-related, and goods with this characteristic tend to have *greater* network externalities.

For industries in which network externalities are important, expectations about the size of the network, i.e., the number of units of the good sold, are a major determinant of the demand for such goods.[2]

This paper analyzes how network externalities and expectations about their size can provide a special role for trade policy. The conditions for such a role to exist are shown to be quite severe. Other characteristics of high-tech industries that may also serve as the basis for government intervention in international trade are briefly mentioned at the end of the paper.

Recent work in international trade theory has led both academics and policy makers to a better understanding of trade policy in imperfectly competitive markets.[3] It is now understood that to the extent that national interests do not include the well-being of foreigners, in particular of foreign firms, there may be a case for trying to draw away the profits of foreign firms. This can be done directly, or if this is illegal, indirectly, by altering the behavior of domestic firms in order to improve their strategic position. Attention has focused on the use of taxes and subsidies for such purposes.

This point was first made in Brander and Spencer (1984) who showed that in a particular strategic setting government subsidization of a domestic firm competing with a foreign firm in a foreign market would improve the domestic firm's strategic position if no other governments attempted this as well. As might be expected, this conclusion aroused a good deal of interest in many circles.

It has become clear through recent work[4] that the appropriateness of this kind of policy depends very much on the nature of the strategic setting. Loosely speaking, if the firms[5] choose their actions on the basis of incorrect beliefs about the actions of other firms and the government understands how these are incorrect and can precommit to tax/subsidy schemes, there is a role for government policy to correct the distortion arising from the incorrect beliefs of the firms. If, for example, a domestic firm expects its foreign rival to keep sales constant while it increases its sales, and in fact its foreign competitors tend to reduce their sales whenever this happens, a wedge exists that can be exploited by a knowledgeable government. In this case the government would give the domestic firm a strategic advantage by subsidizing it. In contrast, if the foreign competitor increased its sales with those of the domestic firm, the optimal policy would be imposition of a tax.

The existence of consumer expectations about network size creates another possible role for government policy. In industries where expectations of network externalities are important, firms may believe that they are unable to influence expectations. This may be an incorrect assumption. If, for example, firms believe that an increase in their output will not increase the expected network size on which consumers base their purchasing decisions, while consumers really do adjust their expectations about network size in response to output changes, then there is a role for a government that knows the true relationship to offset the incorrect beliefs of firms with a subsidy that would induce the firms to produce more.

Another possibility, that in view of existing GATT rules is perhaps more disturbing, relates to the existence of strategic multimarket interactions.[6] Such interactions are bound to be important in those high-tech industries where expected network size affects demand in *all* markets, domestic and foreign. There is a possible role for the government in trying to shift profits from foreign to domestic firms by an appropriate policy for domestic firms exporting to foreign markets. Under these conditions a purely domestic policy, such as a tax/subsidy on consumption for the *domestic market* only will have repercussions for the firm's behavior in foreign markets.

The basic idea can be understood quite easily with a simple example. Consider a situation where the individual firm takes expectations about network size as given. The firm is assumed to compete in both foreign and domestic markets. Network expectations adjust to network size so that in equilibrium the expected network size is the actual one. If the government subsidizes only *national* sales of the product, the firm will produce more.[7] This, in turn, will raise expectations about the network size of the product at home *and* abroad, and therefore affect the product's international competitiveness. This natural interdependence of markets via network effects could be used strategically by a government to affect a firm's behavior in international markets in order to promote the national interest.[8]

This possibility is particularly disturbing as trade laws are designed to deal with direct government subsidization of exported goods, but are not framed in a way to deal with purely domestic policies that have indirect international effects. Under GATT rules, countervailing duties are allowed if there is a foreign subsidy on a product and imports of the product cause material injury or retardation of growth to the domestic industry producing the same good. Thinly disguised subsidies to exports *are* prevented under this clause. An example is the "x radial steel-belted tires" case in which Canada subsidized a tire company to build a new factory in an area with high unemployment. Since virtually all of the product was to be exported and thus likely to cause material injury to U.S. competitors, it was found to be countervailable. The countervailing duty provisions clause cannot be used, however, in the case of "purely domestic" policies, i.e., where the subsidy applies only to goods consumed domestically. This leaves only the last resort, the escape clauses, as the means to deal with such policies. These provisions can be used if increased imports cause or threaten serious injury to domestic producers or if increased imports threaten national security. The requirements for obtaining protection by these two routes are quite stringent, however. Thus, "purely domestic" policies with favorable effects on international competitiveness could look quite attractive as a means of promoting exports.

The next sections present a simple model that helps isolate and interpret the effects of network externalities and expectations on optimal trade policy. Two versions of the model are considered in the next two sections. Section 11.2 examines the implications for profit-shifting possibilities of the two previously mentioned characteristics of high-tech industries, network externalities and expectations about them. Section 11.3 contains an analysis of the nature of multimarket interactions that occur because of these characteristics and the implications of these interactions for trade policy. The last section discusses some other characteristics of high-tech industries and the problems they may and do cause for trade policy.

11.2 Expectations, Network Externalities, and Profit Shifting

Recent work on the role of government policy when oligopolistic firms operate in international markets has focused on the possibility of profit shifting from foreign to domestic firms and on the trade-off between the gains to domestic firms from such profit shifting and the losses to domestic consumers. A number of recent papers have developed this idea. One of the earliest papers is by Brander and Spencer (1984), who show in a model with one home firm and one foreign firm acting as Cournot duopolists and competing in a third market, that the optimal government policy is to subsidize exports. Dixit (1984) extends this result to cases with many firms and shows that the same result holds as long as the number of domestic firms is not too great. Eaton and Grossman (1986), in an insightful paper, show that the Brander and Spencer result can be interpreted as a special case of a more general policy. Their basic interpretation is in terms of a government acting in response to differences between conjectured and actual responses of foreign firms to changes in the domestic firms' output when they are competing in a third market.[9] They also develop a number of extensions, including allowing for many firms and domestic consumption.

As argued previously, demand for a firm's product depends on the expected size of the "network," that is, the expected number of units of compatible goods sold. These expectations are very important in industries with network externalities. Government intervention may be useful in influencing these expectations. This idea is explored in this section using a model that embeds the Eaton and Grossman model in it.[10] Use is made of the simplest version of the model that makes the point, namely, the case where a domestic and foreign firm compete in a third market *and* there is no consumption of the product in either the home or foreign country. Extensions along the lines of allowing more firms or domestic consumption are possible, and the interested reader can use Eaton and Grossman (1986) as a guide to do so. The next section analyzes multimarket interactions with firms competing in both the domestic and foreign markets.

When network externalities exist, a consumer's willingness to pay for a product depends on the expected network size for the product. The products of the two firms could be compatible or incompatible with each other, and are substitutes for each other. If they are compatible, expected network size is the expected total output of both firms; if incompatible, the network is the expected output of each firm. The inverse demand functions for the home and foreign firms are given by $P(x,x^*,N^E)$ and $P^*(x,x^*,N^{*E})$, where x,x^* and N^E, N^{*E} are the outputs and expected network sizes of the home and foreign firms, respectively. The superscript E denotes that these are the expected levels of these variables. If the products are compatible, $N^E = N^{*E} = x^E + x^{*E}$. If they are incompatible, $N^E = x^E$ and $N^{*E} = x^{*E}$. Of course, price, P, falls as x or x^* rises since the products are substitutes, and rises with increases in the expected network size. Similarly, P^* rises as N^{*E} rises and falls as x or x^* rises.[11]

Consumers are assumed to base their demand for a firm's product on the expectations they hold about a firm's network size. Firms take these expectations as dependent on their output. They assume that a unit change in $x(x^*)$ creates an $\epsilon(\epsilon^*)$ change in the expected domestic (foreign) output with consequent effects on expected network size. The special case where expectations about network size do not change as the firm's output changes arises when ϵ and ϵ^* equal zero. However, in general, expectations are perceived as being affected by a firm's output. In addition, firms have conjectures about how their opponent will react to changes in their output. γ and γ^* denote the conjectural variations parameters of the domestic and foreign firms.

Finally, expectations about network size must fulfill a consistency condition that allows them to be tied down. A natural condition is that expectations about the network sizes of the firms are fulfilled in equilibrium. This defines a "fulfilled expectations equilibrium." It is useful expositionally to be slightly more abstract at this time. An (e,e^*) fulfilled expectations equilibrium is said to occur when the expected domestic output equals e times actual domestic output, and expected foreign output equals e^* times actual foreign output. This corresponds to a fulfilled expectations equilibrium if both e and e^* equal one.

The profits of the domestic and foreign firms are given by

$$(1) \qquad (1 - t)\, P(x,x^*,N^E)x - c(x)$$

and

$$(2) \qquad P^*(x,x^*,N^{*E})x^* - c(x^*),$$

respectively.

t is the tariff or subsidy imposed on the domestic firm, and $c(.)$ and $c^*(.)$ are the cost functions of the two firms. The first order conditions when the networks of the two products are incompatible are given by

$$(3) \qquad (1 - t)\,[(P_1 + \gamma P_2 + \epsilon P_3)x + P] - c' = 0,$$

$$(4) \qquad (P_1^*\gamma^* + P_2^* + \epsilon^* P_3^*)x^* + P^* - c^{*\prime} = 0,$$

where subscripts denote partial derivatives. The subscript 1, for example, identifies the first variable as being the relevant one. If the products are compatible, they are given by

$$(3') \qquad (1 - t)\,\{[P_1 + \gamma P_2 + (\epsilon + \epsilon^*\gamma)P_3]x + P\} - c' = 0$$

$$(4') \qquad [P_1^*\gamma^* + P_2^* + (\epsilon^* + \gamma^*\epsilon)]x^* + P^* - c^{*\prime} = 0.$$

In addition, the (e, e^*) fulfilled-expectations equations,

$$(5) \qquad x^E = e\,x$$

$$(6) \qquad x^{*E} = e^*x^*$$

must be met. Substituting (5) and (6) into (3) and (4) or (3′) and (4′) gives two equations to solve for the only two variables, x and x^* in these equations. Equations (5) and (6) then define expectations. Therefore, the effect of a change in t on the endogenous variables x and x^* in such an equilibrium can be found by performing comparative statics analyses on (3) and (4) or (3′) and (4′), after substituting (5) and (6) into them. Let the actual change in x^* as x changes be given by g. This is defined by equations (4) or (4′), after equations (5) and (6) have been substituted into them. It also equals the ratio of the comparative statics terms, $\frac{dx^*/dt}{dx/dt}$.

The problem is now fully specified. Firms maximize their profits taking any taxes and subsidies by the government as given. These first-order conditions for the firms define their best-response functions which give two equations in x, x^*, x^E, and x^{*E}. The condition that the equilibrium be an (e,e^*) fulfilled expectations equilibrium gives another two equations in these four variables. This allows solving for the endogenous variables x, x^*, x^E, and x^{*E}.

The question of optimal government policy can now be analyzed. Since the firms compete in a third market, welfare consists only of domestic profits,[12] and is given by $W = P(x,x^*,N^E)x - c(x)$.

t does not affect welfare directly, since transfers between the government and firms cancel out, but it does affect welfare by its effect on the endogenous variables. Hence,

(7) $$\frac{dW}{dt} = [(P_1 + P_2g + P_3e)x + P - c']\frac{dx}{dt}$$

if the products are incompatible, and

(7′) $$\frac{dW}{dt} = \{[P_1 + P_2g + P_3(e + ge^*)]x + P - c'\}\frac{dx}{dt}$$

if they are compatible.

Using the first-order condition (3) in (7) and (3′) in (7′) allows the welfare changes to be expressed as

(8) $$\frac{dW}{dt} = \left\{[P_2(g - \gamma) + P_3(e - \epsilon)]x + \frac{t}{1 - t}c'\right\}\frac{dx}{dt}$$

if the products are incompatible, and by

(8′) $$\frac{dW}{dt} = \left(\{P_2(g - \gamma) + P_3[(e - \epsilon) + (ge^* - \gamma\epsilon^*)]\}x + \frac{t}{1 - t}c'\right)\frac{dx}{dt}$$

if the products are compatible.

The first-order conditions for an interior welfare maximum require (8) or (8′) to be zero depending on whether the products are incompatible or compatible. This gives the optimal policy assuming that second-order conditions are met. Notice that the optimal value of t depends on the direction of both the wedge between conjectured and actual responses of the foreign firm to own output changes, $(g - \gamma)$, à la Eaton and Grossman, as well as on the difference between the conjectured change in expected network size in response to own output and the actual change. This difference depends only on $(e - \epsilon)$ if products are incompatible, but on the additional interaction term $(ge^* - \gamma\epsilon^*)$ as well when products are compatible.

Consider first the case when products are incompatible. The difference between g and γ defines a reason for the government to set $t \neq 0$. If $g < \gamma$ and $e = \epsilon$, the government should subsidize the domestic producer. This is because the domestic firm is too pessimistic in its conjecture about the foreign firm's behavior. If, for example, $\gamma = 0$ and $g < 0$, the usual Cournot case, the domestic firm acts on the assumption that the foreign one will keep its output fixed. However, since its opponent actually reduces its output in response to any increase in domestic output, the domestic firm should produce more. The government can ensure this by subsidizing the domestic firm, as was pointed out by Eaton and Grossman.

The interpretation of $(e - \epsilon)$ is similar. If $e > \epsilon$, the domestic firm should be subsidized since the firm conjectures a smaller change in the expectations of consumers about network size in response to output changes than actually occurs. This leads them to produce too little. If, for example, firms take the expected network size as given, and a fulfilled-expectations equilibrium is considered, there would be reason to subsidize the domestic firm. Expectations are likely to be fixed in the short run, and a fulfilled-expectation condition can be thought of as a static way of incorporating the longer run into the model.[13] If firms tend to take a short-term view of the industry, as is implicit in $\epsilon = 0$, there is a role for a government that is aware of the long-run consequences to take appropriate action.

The interpretation of the case with compatible products is similar. The only difference lies in the fact that any effect of a tariff via the network externality must include the effect on the foreign firm's expected and actual output as well as that of the domestic firm. Notice that $e + ge^*$ is the actual change in the network size, while $\epsilon + \gamma\epsilon^*$ is the conjectured change in the network size. This makes ϵ and γ interact in the formula, but allows the same interpretations to be made as done previously.

It is worth calling attention to a few points at this stage. First, it should be noted that g is the slope of the foreign firm's best-response function after imposing the expectations condition on it. In this it differs from the analogous concept in the absence of any expectations. Therefore, even if $e = \epsilon$, the introduction of expectations would tend to make the assumption $g = \gamma$ even stronger since g is not the slope of the best response function of the foreign firm for *given* expectations but when expectations are fulfilled in the (e,e^*) sense.

Second, if $\epsilon = 1 = e$ and a firm fully takes into account the effects of its actions on the network size, then in the case with incompatible products the direction of optimal policy depends on the sign of $(g - \gamma)$ only. Also notice that the direction of the optimal policy when $e = \epsilon = 1 = e^* = \epsilon^*$ in the case of compatible products is dependent on more than just the sign of $(g - \gamma)$. If $P_2 + P_3$ is positive, even if P_2 is negative, the goods would become effective *complements* because of the presence of network externalities. In this case the incentives to subsidize would, of course, be reversed since a decrease in output by a competitor hurts rather than helps a firm when the goods are complements. Thus, if $\epsilon = \epsilon^* = e^* = e = 1$, $P_2 + P_3$ is positive, and $g < \gamma = 0$, as in the Cournot case, the anticipation that the other firm would keep its output fixed would be too optimistic if it really lowered it. Obviously, the optimal policy would then be a tax which would correct the firm's over-optimism.

Third, note that having compatible products tends to reduce the desirability of a subsidy or a tax when $g = \gamma < 0$. Consider, for example, the case where $e = e^*$, $\epsilon = \epsilon^*$ but $e > \epsilon$ and $g = \gamma < 0$. The direct effect of a subsidy is beneficial since the firms underestimate the value of the network externality. This is captured by the $P_3(e - \epsilon)$ term. A subsidy, however, raises the foreign firm's network as well and tends to make it wish to produce more. If $g < 0$, this makes the domestic firm produce less. This is captured by the term $P_3 g(e^* - \epsilon^*)$. This works against the desirability of a subsidy.

Thus, network externalities and expectations regarding the size of the network affect optimal trade policy for oligopolistic industries in two ways. First, the presence of expectations effects creates a wedge if there are differences in the way the network externalities really work, as given by e and e^*, and the way they are expected to work, as given by ϵ and ϵ^*. This wedge creates a role for government taxation/subsidization to correct the "distortion." Second, when the goods are compatible the existence of network externalities in the absence of any expectations distortions tends to make goods complementary. If in fact this effect dominates, the direction of optimal policy is reversed.

In the next section, the importance of network externalities is shown to create a reason why success in one market can help bring about success in another. The analysis also provides an example of the idea that import protection can act as export promotion, as in Krugman (1984).

11.3 Multimarket Interactions

11.3.1 Introduction

Multimarket interactions are said to exist when decisions made in one market spill over into another by affecting optimal decisions there. The existence of such interactions is important for two reasons. First, it creates problems in identifying unfair trade practices since purely "domestic" policies could actually be trade policies in disguise. Second, such interactions are bound to exist in markets with network externalities, both because markets are linked by common networks and because expectations about network size are a determinant of demand and can be affected by domestic government policy.

The topic of multimarket oligopolies has aroused a great deal of interest recently. The work of Bulow, Geanakoplos, and Klemperer (1985), Fudenberg and Tirole (1984), Krugman (1984), and Baldwin and Krugman (1986) is closely related to this part of the paper. Baldwin and Krugman (1986) focus on an important technological aspect of the production of 16K RAMS: the fact that experience lowers the effective cost of production. This creates multimarket interactions that are made important by the extremely large experience effects estimated to occur in this industry. They develop a model that is rich enough to capture the particular aspects of learning-by-doing in this industry, and then use their theoretical structure in a simulation exercise to see if the effective closure of the Japanese market to imports played a critical role in developing Japanese superiority in this area. Their results indicate that this closure did indeed play a critical role. In this spirit, any domestic policy that raised Japanese domestic output of semiconductors could have significant trade effects.

Bulow, Geanakoplos and Klemperer (1985) examine many examples of multimarket interactions. The core of their work is their definition of "strategic complements and substitutes" and they show that these play a crucial role in the results of many oligopoly models.[14] The approach of Eaton and Grossman (1986) can also be extended, as is done in this paper, to better understand such interactions in markets with the characteristics previously mentioned. This approach provides a way of understanding multimarket interactions that is complementary to that of Bulow, et al. (1985). It focuses on the wedges created by differences between how firms expect the relevant variables to affect profits and how they actually do so. These wedges create an opportunity for possible government intervention.

While many possibilities for multimarket interactions have been discussed, network externalities and expectations concerning network size have been neglected. In what follows, this paper will first discuss informally how such network externalities make "success" across markets positively correlated and then examine in a more formal way the differences in the roles played by expectations and network externalities in such interactions.

11.3.2 Network Externalities, Expectations, and Market Interactions

Both the existence of network externalities and expectations about them create linkages between markets and give rise to the possibility that government policy in one market can affect a firm's competitive edge in another.

Consider for example a firm operating in two markets, a home and a foreign market, and facing the *same* competitor in both of these markets. Assume for concreteness that the two firms are Cournot multimarket duopolists who produce incompatible products so that each firm's expected network size is the size of its expected output in all its markets. A fulfilled expectations equilibrium[15] where firms take expectations about network size as given will be considered. Equilibrium is therefore characterized by each firm's maximizing profits by choosing its sales in each market, taking as given its competitors' output and expectations about network size. In order for expectations to be fulfilled, in equilibrium each firm's total output must equal the expected network size as well.

Any subsidy on domestic sales will tend to raise total output of the domestic firm and lower the total output of the foreign firm. In a fulfilled-expectations equilibrium, greater output will lead to greater expectations about the network size of the domestic firm and smaller expectations of the foreign network size. This will help the domestic firm and hurt the foreign firm in *both* markets. Notice that domestic policy has international effects because of the role played by expectations. The same kind of argument works even if firms do not take expectations as given but assume they are equal to their total output, since greater sales in the domestic market raise marginal revenue in the foreign market because of the effect of network externalities. Network externalities by themselves also create multimarket interactions.

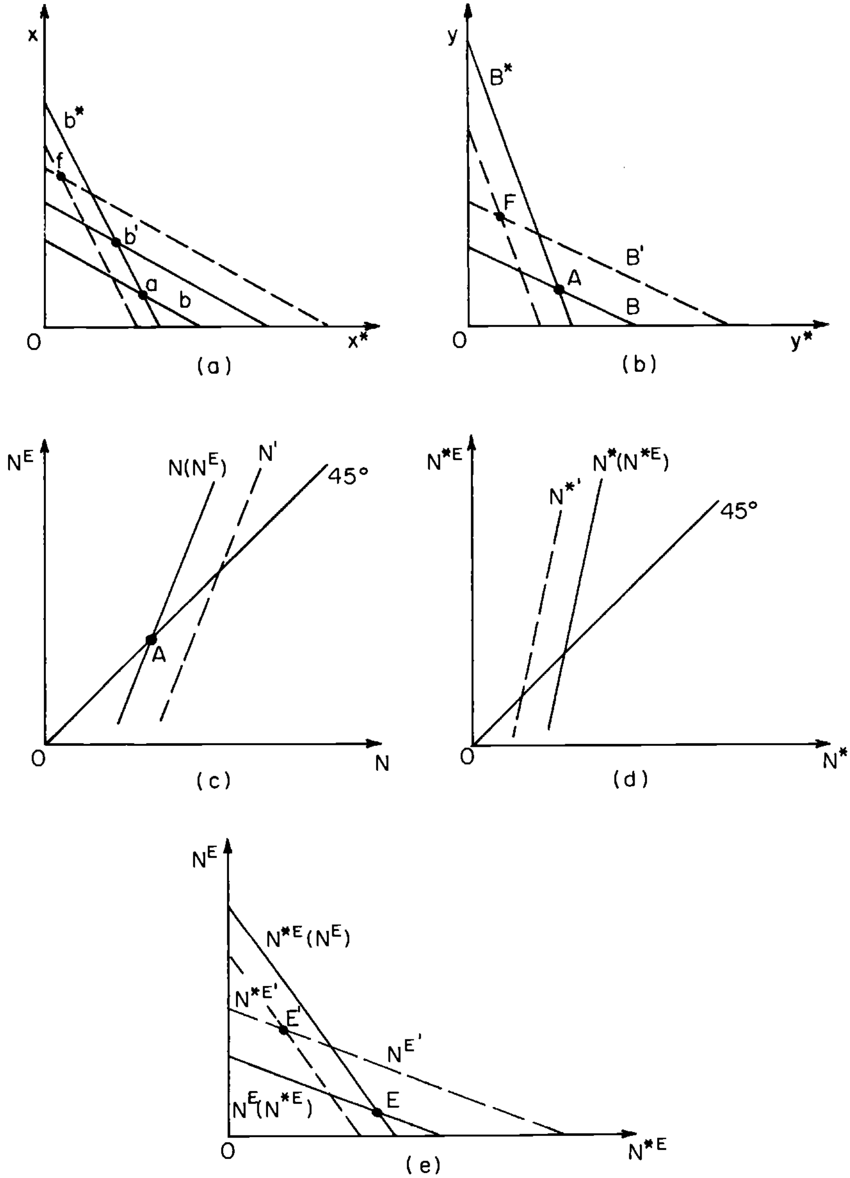
The preceding argument can be made clearer by using a series of diagrams to illustrate the process (see figure 11.1).[16] It can be verified that the same kinds of effects occur even when the effects of output changes on expectations are taken into account by firms. Some notation is required at this point to help follow the diagrams used to illustrate the process by which these multimarket interactions occur. Since the products are incompatible, each firm's network consists of its total expected output in the two markets. The firm's problem is, therefore, to

$$\underset{x,y}{\text{Max}}\ \pi(x,y|x^*,y^*,N^E) = r(x,x^*,N^E) + R(y,y^*,N^E) - c(x+y),$$

where x,y are output levels of the domestic producer in the two markets; x^* and y^* are the competitor's outputs in the markets; and c is the constant marginal cost of the home firm.[17] N^E is the expected network size of the home firm. The home firm's revenue functions in the two markets are r and R and are assumed to have the usual properties, r_2, r_{11}, $r_{12} < 0$ and $r_3 > 0$. It is also assumed that R_2, R_{22}, $R_{12} < 0$ and $R_3 > 0$. The home firm takes x^*,y^*, and N^E as given. This is denoted by the profit function, π, being conditional on given values of these variables. Similarly, the foreign firm's problem is

$$\underset{x^*y^*}{\text{Max}}\ \pi^*(x^*,y^*|x,y,N^E) = r^*(x,x^*,N^{*E}) + R^*(y,y^*,N^{*E})$$
$$- c^*(x^* + y^*).$$

Therefore, equilibrium in the home market (depicted in figure 11.1(a)), where the revenue functions of the home and foreign firm are given by r and r^*, is characterized by the intersection of the best response functions, b, b^*, implicitly defined by $\pi_x = 0$ and $\pi^*_{x^*} = 0$. Similarly, equilibrium in the foreign market (shown in figure 11.1(b)) is defined by $\pi_y = 0$ and $\pi^*_{y^*} = 0$. Both these equations hold at the intersection of B and B^* which are defined by these equations. The usual stability



x
b*
f
b'
a
b
O
x*
(a)
y
B*
F
B'
A
B
O
y*
(b)
N^E
N(N^E)
N'
45°
A
O
N
(c)
N*E
N*'
N*(N*E)
45°
O
N*
(d)
N^E
N*E(N^E)
N*E'
E'
N^E'
E
N^E(N*E)
O
N*E
(e)

Fig. 11.1

conditions are also assumed in figures 11.1(a) and (b). These are equilibria only for the *given* expectations, however. In addition, these expectations must be fulfilled. For a *given* N^{*E}, it is easy to verify that increases in N^E shift the home firm's best response function outwards in both markets and so raise its equilibrium output in both markets. Therefore total output, N, of the domestic firm rises with N^E as shown in figure 11.1(c) by $N(N^E) = N^E$.

What happens to A as N^{*E} changes? Since an increase in N^{*E} shifts B^* and b^* outward, it must reduce N for any N^E. Thus, an increase in N^{*E} shifts $N(N^E)$ inwards so that the N^E that is self-fulfilling falls. This relationship between the self-fulfilling N^E and N^{*E} is depicted in figure 11.1(e) as $N^E(N^{*E})$. Since the position of the two firms is symmetric, the same arguments produce another diagram, 11.1(d), which is analogous to 11.1(c), and another function, $N^{*E}(N^E)$, depicted in 11.1(e), which for any N^E gives the expectation of N^{*E} that is self-fulfilling. The intersection of these two loci, $N^{*E}(N^E)$ and $N^E(N^{*E})$, gives the set of expectations about N^E and N^{*E} which are *jointly* self-fulfilling. Once again, the relative slopes of these two functions are as shown for stability reasons.

How would a subsidy program for production for the domestic firm affect a firm abroad? The direct effect of a subsidy with given expectations about network size would be to shift the best response function at home outwards to b', as shown in figure 11.1(a). This raises total output of the domestic firm for the given expectations. In fact, it is easy to show that total output rises for any given expectations. Thus, for any N^{*E}, $N(N^E)$ would shift to the right, to a line such as N' in figure 11.1(c). Hence, for any N^{*E}, the self-fulfilling expectation of N^E would rise, or in other words, $N^E(N^{*E})$ would shift outwards to a line such as $N^{E'}$, in figure 11.1(e).

Moreover, since the subsidy reduces total foreign output with the original set of expectations, it must reduce total foreign output for any given set of expectations, or in other words it must shift $N^*(N^E)$ inwards to $N^{*'}$ as in 11.1(d). This reduces the self-fulfilling expectation level of N^{*E} for any N^E, so that $N^{*E}(N^E)$ shifts in as well to $N^{*E'}$, which is shown in 11.1(e). *Both* the shifts in figure 11.1(e) *raise* the jointly self-fulfilling level of N^E and lower that of N^{*E}. This shifts demand for the domestic product out and the foreign product in in *both* domestic and foreign markets, shifting the equilibrium in these markets to the points f and F from a and A in 11.1(a) and 11.1(b), respectively.

A subsidy to the home firm in the home market raises expectations about its network size, which raises its output in all markets. A similar effect could easily be demonstrated even if firms completely take into account the effects of output changes on expectations, because the size of the network still connects the two markets.

Although this exercise shows how expectations and network externalities can link markets and how a subsidy to domestic sales can raise foreign *and* domestic sales, it does not say much about whether this subsidy is desirable. Fortunately, the model developed in the previous section can be extended to help answer these questions. The only modification that needs to be made is to allow the firms to compete in two markets. The case where firms make incompatible products is analyzed first. The results for compatible products are similar and are presented more briefly later on.

The domestic (foreign) firm is assumed to behave as if it believed that a unit change in the domestic (foreign) network would lead to an $\epsilon(\epsilon^*)$ change in its expected network. γ and Γ are the conjectural variations parameters for the domestic firm in the home and foreign market, and γ^* and Γ^* are the conjectural variations parameters for the foreign firm in the home and foreign markets. r and R are the revenue functions of the domestic firm in the domestic and foreign markets, respectively. r^* and R^* similarly denote the revenues of the foreign firm in these markets. An (e,e^*) fulfilled expectations equilibrium is analyzed as before. Domestic consumption of the domestic firm's output is taxed or subsidized by the government at the rate t. Hence, the profits, π, of the domestic firm are given by

$$\pi = (1 - t)r(x,x^*,N^E) + R(y,y^*,N^E) - c(x + y),$$

and π^*, the profits of the foreign firm, are given by

$$\pi^* = r^*(x,x^*,N^{*E}) + R^*(y,y^*,N^{*E}) - c^*(x^* + y^*).$$

The four first-order conditions are given by

$$\frac{\partial \pi}{\partial x} = (1 - t)(r_1 + \gamma r_2 + \epsilon r_3) + \epsilon R_3 - c = 0 \tag{9}$$

$$\frac{\partial \pi^*}{\partial x^*} = r_2^* + \gamma^* r_1^* + \epsilon^* r_3^* + \epsilon^* R_3^* - c^* = 0 \tag{10}$$

$$\frac{\partial \pi}{\partial y} = R_1 + \Gamma R_2 + \epsilon R_3 + \epsilon r_3(1 - t) - c = 0 \tag{11}$$

$$\frac{\partial \pi^*}{\partial y^*} = R_2^* + \Gamma^* R_1^* + \epsilon^* R_3^* + \epsilon^* r_3^* - c^* = 0. \tag{12}$$

The first two equations define equilibrium in the home market given y^*,x^*, and the second two define equilibrium in the foreign market given x,y. The condition that expectations be (e,e^*) fulfilled requires that in addition $N^E = e(x + y)$ and $N^{*E} = e^*(x^* + y^*)$. These conditions will give the equilibrium levels of x, x^*, y and y^* as a function only of t.

Also, comparative statics on the system will give the effects of changing t on these endogenous variables. These comparative statics results are denoted by $\frac{dx}{dt}$, $\frac{dx^*}{dt}$, $\frac{dy}{dt}$, and $\frac{dy^*}{dt}$ and can be found by substituting for the expectations conditions in equations (9) through (12) before performing the comparative statics exercise.

For simplicity, the welfare function is broken into two components, consumer surplus, W^c, and profits, W^π. The effects of t on the two components are analyzed separately. This isolates the strategic multimarket profit-shifting effects, so that they can be analyzed clearly. Notice that in (13), welfare depends on t only indirectly via the effect of t on the endogenous variables.

(13) $$W^\pi = r[x, x^*, e(x + y)] + R[y, y^*, e(x + y)] - c(x + y).$$

(14) $$\frac{dW^\pi}{\mathrm{d}t} = (r_1 + r_3 e + R_3 e - c)\frac{dx}{dt} + (r_2)\frac{dx^*}{dt} + (R_1 + R_3 e + r_3 e - c)\frac{dy}{dt} + (R_2)\frac{dy^*}{dt}$$

Using equations (9) and (11) we can substitute for $r_1 - c$ and $R_1 - c$ in equation (14). Also, let g be the *actual* change in x^* relative to the *actual* change in x as t changes. In other words, $g = \frac{dx^*/dt}{dx/dt}$. Similarly, $G = \frac{dy^*/dt}{dy/dt}$, and $h = \frac{dy/dt}{dx/dt}$. Now, equation (14) can be expressed as

(15) $$\frac{dW^\pi}{dt} = \{[(c - R_3\epsilon)t/(1 - t)] + h\epsilon r_3 t + (g - \gamma)r_2 + (G - \Gamma)R_2 h + (r_3 + R_3)(e - \epsilon)(1 + h)\}\frac{dx}{dt}.$$

The first-order conditions for a welfare maximum will give t to be zero optimally if actual changes due to a slight change in tariffs are equal to the conjectural changes, or if $g = \gamma$, $G = \Gamma$, and $e = \epsilon$.

The previous Cournot example can be analyzed in this framework by setting $\gamma = 0 = \Gamma$, $G < 0$, $g < 0$, and $\epsilon = 0$, $e = 1$, $h > 0$. Since $(g - \gamma)r_2 > 0$ and $(G - \Gamma)R_2 > 0$, these effects call for a subsidy on domestic production. This is the standard effect that depends on the form of competition, as pointed out by Eaton and Grossman (1986).

Moreover, notice that although the subsidy is imposed at home, the effects of a subsidy are desirable in both markets. This is evident in there being two terms, one for the domestic market and one for the foreign market. A subsidy is desirable in the home market since the domestic firm is being too "pessimistic" in its conjectures at home which leads it to produce too little and a subsidy alleviates this distortion. This effect is captured by the term $(g - \gamma)r_2$ being positive. A subsidy is desirable abroad because it causes the domestic firm's output to rise in both markets so that h is positive, and because the domestic firm is being too pessimistic abroad as well. This is captured by the term $(G - \Gamma)R_2h$ being positive.

Expectations affect revenues in both markets. For this reason we see the term $r_3 + R_3$ in equation (15). Since the effects of a subsidy are direct at home and indirect abroad, we see the term $(1 + h)$ multiplying the term $(r_3 + R_3)$ in equation (15). Finally, since $e - \epsilon > 0$ in this case, firms are too conservative in their estimate of the network benefits of increased output. For this case, $(r_3 + R_3)(e - \epsilon)(1 + h)$ is positive, since h is positive and the expectation effect just reinforces the previous effects. Therefore, the optimal policy would be a subsidy. This completes the analysis of profit shifting in the Cournot example.

If $\epsilon \neq 0$, the sign of the terms multiplying t in (15) is ambiguous. However, as long as $\frac{dx}{dt} < 0$ at $t = 0$, similar arguments to those previously made indicate the direction of welfare-increasing policies from an initial state of no taxes or subsidies on domestic consumption of the domestic good. If, for example, firms overestimate the effect of output on network expectations so that $e - \epsilon < 0$, and $g = \gamma$ and $G = \Gamma$, then a small tax on domestic consumption of the domestic firm's product will raise welfare from the $t = 0$ welfare level.

It is clear from the expression for the change in welfare that the optimal policy depends not only on the form of the strategic interaction, as parameterized by Γ and r relative to g and G, but also on the sign of h. In addition, it also depends on the distortions inherent in the expectations formulation.[18]

Now to turn to the effects on consumer surplus, W^c.[19]

(16) $$W^c = U[x, x^*, e(x + y), e^*(x^* + y^*)] - r[x, x^*, e(x + y)] - r^*[x, x^*, e^*(x^* + y^*)]$$

where $U(.)$ is the utility function being maximized.

Differentiating gives:

(17) $$\frac{dW^c}{dt} = \left[\frac{\partial W^c}{\partial x} + \frac{\partial W^c}{dx^*}g + \frac{\partial W^c}{\partial y}h + \frac{\partial W^c}{\partial y^*}Gh\right]\frac{dx}{dt}$$
$$= [(U_1 - r_1 + eU_3 - er_3 - r_1^*) + (U_2 - r_2^* - r_2 + U_4e^* - r_3^*e^*)g + (U_3 - r_3)eh + (U_4 - r_3^*)e^*Gh]\frac{dx}{dt}.$$

The four terms in brackets give the effect of changes in x, x^*, y, and y^* because of changes in t on consumer surplus. Since $U_1 = P$, the inverse demand function facing the domestic producer at home, $U_1 - r_1$, is positive. Similarly, $U_2 - r_2^*$ is also positive. $U_3 - r_3$ is positive/negative if an increase in the network size raises utility more/less than it raises revenues. The sign of this term is ambiguous and depends on the particular specification of demand used. A useful interpretation, along the lines of Spence (1976), can be made as follows.

If increments in network externalities are valued less for marginal units than for all units on average, then $U_3 - r_3$ is positive. If the increments in network externalities are valued more for marginal units than for all units on average, then $U_3 - r_3$ is negative. This is because

$$(18)\quad U_3[x, x^*, e(x + y), e^*(x^* + y^*)] - r_3[x, x^*, e(x + y)]$$
$$= \textstyle\int_o^x U_{31}[s, x^*, e(x + y)]ds - P_3[x, x^*, e(x + y)]x$$
$$= x\left\{\frac{1}{x}\textstyle\int_o^x P_3[s, x^*, e(x + y)]ds - P_3[x, x^*, e(x + y)]\right\}.$$

The first term is the average willingness to pay for increments in the network size over all units purchased while the latter is the willingness to pay at the margin for increments in network size.[20] The interpretation of $U_4 - r_3^*$ is similar to this. Also, r_1^* and r_2 are negative since the goods are substitutes. The effects of a tax or subsidy on consumer surplus can now be analyzed.

Assume that a tax lowers x. Consumer surplus is affected through four channels, x, x^*, y and y^*, as shown. First consider the effect by means of x directly. A tax reduces x and since the fall in utility exceeds the fall in expenditure, this reduces consumer surplus. This is captured by the term $U_1 - r_1$ being positive. The fall in x also reduces the network size. This is captured by $U_3 - r_3$. If $U_3 - r_3$ is positive, the fall in the network size will also reduce consumer surplus. If $U_3 - r_3$ is negative, it will raise consumer surplus. Since the goods are substitutes, $r_1^* < 0$ and the fall in x will raise the revenues of the foreign firm in the domestic market which, for a given level of x^*, will reduce consumer surplus. Therefore, the effect of a tax via x reduces consumer surplus as long as $U_3 - r_3 > 0$.

Now turn to the effect via x^*. If the fall in x raises x^*, i.e., $g < 0$, and $U_4 - r_3^* > 0$, then $g\left(\frac{\partial W^c}{\partial x^*}\right) < 0$. A tax then *raises* consumer surplus via its effect of raising x^*.

y effects consumer surplus only via its effect on network size. If $h > o$, so that a tax reduces sales in both markets, then the effect by means of y also reduces consumer surplus if $U_3 - r_3 > 0$.

y^* also affects consumer surplus only through its effect on network size. If $G < 0$, $h > 0$, then the tax raises y^* thereby raising the network for the foreign firm and raising consumer surplus if $U_4 - r_3^* > 0$.

The total effect of a tax on consumer surplus is therefore rather complicated and consumer surplus could rise or fall with a tax. For the Cournot example previously discussed, if the average increase in the willingness to pay associated with an increase in network size exceeds the marginal increase in the willingness to pay, and direct effects on surplus by x and y outweigh the relatively indirect ones by x^* and y^*, a tax *reduces* consumer surplus. Thus, if a subsidy is called for because of strategic considerations in maximizing W^π, it will also *raise* consumer surplus.

Exactly the same procedure can be used to define the welfare effects of a tax or subsidy when the products are compatible. The analogous expression to equation (15) is somewhat formidable. With compatible products W^π is given by

$$W^\pi = r[x, x^*, e(x + x^* + y + y^*)] + R[y, y^*, e(x + x^* + y + y^*)] - c(x + y).$$

Then,

$$\frac{dW^\pi}{dt} = \Bigg(t\left[\frac{c - R_3\epsilon(1 + \gamma)}{1 - t} + h\epsilon r_3(1 + \Gamma)\right] + (r_3 + R_3)\{e[(1 + g) + (1 + G)h] - \epsilon[(1 + \gamma) + (1 + \Gamma)h]\} + (g - \gamma)r_2 + h(G - \Gamma)R_2\Bigg)\frac{dx}{dt}. \tag{19}$$

Notice that even with compatible products there is a role for subsidizing domestic consumption of the domestic firm. If, for example, $e - \epsilon > 0$, $g = \gamma < 0$, $G = \gamma < 0$, $h > 0$, $\frac{dx}{dt} < 0$ and $[(1 + g) + (1 + G)h] > 0$, then $\frac{dW^\pi}{dt} < 0$ for t close to zero, so that a subsidy raises domestic profits. However, with compatible products, some of the benefits of a larger network accrue to the foreign firm, and even if $e > \epsilon$, it may not be worthwhile subsidizing domestic consumption in order to shift profits. This is captured by the fact that $(1 + g) + (1 + G)h$ is required to be positive as well in this case. Also,

$$W^c = U[x, x^*, e(x + x^* + y + y^*)] - r[x, x^*, e(x + x^* + y + y^*)] - r^*[x, x^*, e(x + x^* + y + y^*)].$$

Therefore,

$$(20)\qquad \frac{dW^c}{dt} = \{[u_1 - r_1 + (u_3 - r_3 - r_3^*)e - r_1^*] + [u_2 - r_2^* + (u_3 - r_3 - r_3^*)e - r_2]g + [(u_3 - r_3 - r_3^*)e](h + Gh)\}\frac{dx}{dt}.$$

It can, however, be analyzed as was done for incompatible products.

The basic message of this section and the last one is fairly clear. If firms tend to underestimate the benefits of output increases in creating network externalities, there will be a role for government intervention both to shift profits to domestic firms from foreign firms in a third market, and to use subsidies on domestic sales to help their competitive position in foreign markets where it may be illegal to offer such subsidies. In addition, such subsidies may also raise consumer surplus.

This should not be taken as a call for government action to subsidize domestic production for the domestic market for at least three reasons. First, governments may not be informed enough to identify a welfare-increasing policy. Second, even if a welfare-increasing policy is identified, the government may not be able to implement it since the possibility of subsidization may unleash lobbying efforts which endogenously determine the policy as well as waste resources. Third, foreign governments may well retaliate with consequent possible losses for all parties. However, since these domestic subsidies are legal under the GATT, governments will be tempted to use them in the hope that they will be beneficial. For this reason trade policy toward certain high-tech industries could easily be conducted in an extremely non-cooperative way with consequent losses for all parties.

11.4 Other Features of High-Tech Industries

There are other characteristics of high-tech industries that make this sector special and pose difficulties for the trading system. One feature of such industries, which is also related to the existence of network externalities, is that firms have a choice of what product standards to adopt or which network to link to. This choice is often posed as one of deciding whether to make one's product compatible with a competitor's products. This matter has at least two aspects that are relevant for trade policy. The first is that in an effort to keep out competition, firms may deny networks linkages to competitors by making their product incompatible with products of foreign firms, thereby effectively impeding competition. Often international competition is more effective in holding down excess profits than domestic competition, given the size of some firms in these industries.

Aho and Aronson (1985) recognize this problem. They point out that "except for the United States and Canada almost all major countries provide telecommunication services through government-owned or -controlled postal, telegraph, and telephone authorities. Neither group of countries is likely to abandon their regulatory preferences; therefore, rules need to be negotiated to allow for fair competition between public and private sector firms" (Aho and Aronson 1985, 147).

The second trade policy aspect of such compatibility decisions is that trade restrictions in product lines where network externalities are important may well affect the nature of compatibility choice. The manner in which they might do so is not well understood at present.

High-tech industries are also characterized by high rates of technological change and the presence of very significant rates of experience effects. For example, the capabilities of a modern personal computer worth $2,000 are equivalent to those of a mainframe computer that cost several million dollars in the early seventies. Nor is the end in sight for this technological revolution. Technological change has reduced the real price of a unit of computing capacity in the semiconductor industry by 99 percent between 1976 and 1984.[21]

In the semiconductor industry there are also significant experience effects. This comparative advantage in such industries can be "made" to a large extent.[22] This puts enormous pressure on governments to act to secure the advantages brought by experience for domestic firms, since these industries are likely to be critical ones, both economically and for national security. Recent work by Baldwin and Krugman (1986) paints a convincing picture using a simulation model, that current Japanese superiority in semiconductors may well be due to the effective closure of the Japanese market to foreign firms that allowed Japanese firms to benefit from experience effects.[23] While this may lead to advantages for a country if it is the only one operating such policies, it is likely to be mutually destructive if all countries subsidize particular high-tech industries to gain an experience advantage.

Still another feature of high-tech industries is their extremely high level of research and development expenditure and the related problem in enforcing property rights, especially for software. Since counterfeiting is becoming a significant trade problem for some high-tech industries, it is important to consider ways of regulating property rights optimally in this area.[24]

Finally, there are likely to be large switching costs and coordination problems in high-tech industries where many possible standards are possible ex ante. For example, it has been suggested that although the DVORAK typing board is more efficient than the QWERTY one,[25] even allowing for retraining costs, the latter remains the standard.[26] This makes it important for national policy on standards to be formulated at an early stage.

Table 11.1 **Leading Items Exported to the European Community (EC), by Schedule B Items, 1983–85 (in thousands of dollars)**

Schedule B Item No.	Description	1983	1984	1985
170.33	Filler tobacco, cigarette leaf, stemmed and unstemmed	426,314	471,983	452,860
175.41	Soybeans, other than seed for planting	2,190,285	1,766,404	1,272,587
184.80	Other animal feeds and ingredients thereof, n.s.p.f.	805,879	728,974	618,134
250.02	Wood pulp; rag pulp; and other pulps derived from cellulosic fibrous materials and suitable for papermaking	650,196	677,733	600,481
433.10	Chemical mixtures and preparations, n.e.s.	419,250	403,945	404,722
521.31	Coal; petroleum and other coke; compositions of coal, coke, or other carbonaceous material used for fuel	1,395,641	1,514,639	1,791,331
660.49	Non-piston-type internal combustion engines	416,833	494,618	386,964
660.54	Parts of compression-ignition piston-type engines, and non-piston-type engines	1,191,283	1,261,055	1,401,292
664.05	Excavating, leveling, boring, extracting machinery, excluding machinery, excluding front-end loaders, pile drivers, not self-propelled snowplows, and parts	625,338	605,353	612,564
676.27	Digital machines comprising in one housing the central processing unit and input and output unit capability	452,898	470,666	536,644
676.28	Digital central processing units, auxiliary storage units, input, units; output units, and combinations thereof	2,145,334	2,648,975	2,369,799
676.55	Parts of automatic data processing, photocopying, calculating, and similar machines incorporating a calculating mechanism	2,392,731	3,046,662	3,013,548
678.50	Machines not specially provided for, and parts thereof	367,746	509,823	589,520
685.90	Electrical apparatus for making, breaking, protecting, or connecting to electrical circuits, switchboards, and control panels, and parts thereof	401,455	504,642	500,777

Table 11.1 (continued)

Schedule B Item No.	Description	1983	1984	1985
687.60	Electronic tubes, transistors, integrated circuits, diodes, rectifiers, mounted piezoelectric, related electronic crystal components, parts	630,077	823,152	778,130
692.29	Parts of motor vehicles, n.e.s.	404,148	395,975	433,421
694.40	Airplanes	1,112,107	1,027,215	1,700,447
694.65	Parts, for aircraft and spacecraft	1,413,759	1,470,228	1,521,124
712.50	Instruments and apparatus for measuring or checking electrical quantities, except electricity meters, and parts thereof	520,980	564,989	598,655
818.90	General merchandise valued under $1001, except shipments requiring a validated export license*	197,675	240,038	406,042
	Total	18,159,928	19,627,066	19,989,044
	Total, U.S. exports to the EC	42,420,383	44,795,655	43,595,970

Source: From the 37th Report on the Operations of the Trade Agreements Program. U.S. International Trade Commission, 1985. Table B-3, 292.

Note: Because of rounding, figures may not add to the totals shown.

*Prior to 1 January 1985, Schedule B, item 818.90 included only general merchandise valued at $500 or less.

Table 11.2 **Leading Items Imported from the European Community (EC), by TSUS Items 1983–1985 (in thousands of dollars)**

TSUS Item No.	Description	1983	1984	1985
167.30	Still wine from grapes, not over 14 percent alcohol, in containers not over 1 gallon	563,423	605,615	628,159
422.52	Uranium compounds except uranium oxide	429,775	546,634	600,701
475.10	Crude petroleum, topped crude petroleum, crude shale oil, distillate and residual fuel oils, testing 25 degrees a.p.i. or more	4,360,843	4,683,164	2,999,563
475.25	Motor fuel, including gasoline and jet fuel	801,491	1,064,310	1,434,738
520.32	Diamonds not over ½ carat, cut, not set, suitable for jewelry	388,261	476,172	491,275

Table 11.2 (continued)

TSUS Item No.	Description	1983	1984	1985
660.61	Internal combustion engines, non-piston-type, for aircraft, certified for use in civil aircraft	464,008	532,162	787,249
660.73	Parts for internal combustion engines, certified for use in civil aircraft	348,998	374,651	610,944
676.15	Accounting, computing, and other data-processing machines	126,558	237,054	550,502
676.52	Office machine parts, n.e.s.	314,162	541,386	648,971
678.50	Machines, n.s.p.f., and parts thereof	298,240	528,220	581,860
692.10	Passenger automobiles, snowmobiles, trucks valued under $1000, and other miscellaneous vehicles	4,862,718	6,199,971	8,287,250
692.32	Parts n.s.p.f. of motor vehicles not allowed nor advanced beyond cleaning, partly machined	565,255	776,252	961,549
692.34	Tractors suitable for agricultural use and parts thereof	508,881	617,433	545,792
694.41	Airplanes and parts thereof of civil aircraft and spacecraft	549,784	883,814	1,233,495
700.45	Leather footwear n.e.s., valued over $2.50 per pair, not for men, youths, or boys	467,371	552,510	639,191
712.49	Electrical measuring, checking, analyzing, or automatically controlling instruments or apparatus, n.s.p.f., and parts thereof	315,923	454,655	561,343
740.14	Jewelry and other objects of personal adornment, of precious metals, n.e.s.	218,645	336,300	547,653
765.03	Paintings, pastels, drawings, and sketchings executed wholly by hand, orginal or not	410,426	475,601	497,197
800.00	U.S. goods returned	1,064,611	1,428,986	1,462,389
999.95	Under $251 formal and informal entries, and nonexempt items from $251 to $1,000, estimated†	105,249	137,599	530,716
	Total	17,164,591	21,452,490	24,660,539
	Total, U.S. imports from the EC	43,767,725	56,876,278	64,506,294

Source: From the 37th Report on the Operations of the Trade Agreements Program. U.S. International Trade Commission, 1985. Table B-4, 293.

Note: Because of rounding, figures may not add to the totals shown.

†Prior to 1 January 1985, TSUS Item 999.95 included only formal and informal entries under $251.

Notes

1. For a discussion of the nature of such externalities, see Katz and Shapiro (1985).

2. The classic example of this comes from the computer industry. Although when the Macintosh came out it was universally regarded as a far superior machine than the IBM PC, its main competitor, the expectation that the IBM machines would ultimately set the industry standard gave IBM a definite competitive edge over Apple. See Pepper (1986) for a discussion of this.

3. See Dixit (1984, 1985) and Grossman and Richardson (1985) for a survey of this work.

4. In particular, the work of Eaton and Grossman (1986) and Bulow, Geanakoplos, and Klemperer (1985) have contributed to this.

5. It is worth emphasizing that the government may not know which way to precommit, and even if it does, it may not be able to do so credibly.

6. See Bulow, Geanakoplos, and Klemperer (1985) and Fundenberg and Tirole (1984) for more on this topic. Multimarket interactions exist when a firm's behavior in one market affects its optimal behavior in another.

7. This could be accomplished by a domestic consumption subsidy on the firm's product or a production subsidy coupled with a requirement that the subsidy be rebated if the product is exported.

8. This is of course assuming no retaliation!

9. See Bresnehan (1981), Perry (1982), and Kamien and Schwartz (1983) on conjectural variations and consistent conjectural variations. There may be significant problems with the existence of an equilibrium in such models, which are not addressed in this paper.

10. The usual objections to conjectural variations in game theory, such as the lack of an extensive form associated with the game, are important to note. Nevertheless it remains a useful tool.

11. In general N^{*E} and N^E could also enter P and P^* respectively, and this can easily be incorporated in the framework provided. A model which provides a special case of the one presented is that of Katz and Shapiro (1985). In their model goods are perfect substitutes for each other so that inverse demand depends on *total* output and own expected network size.

12. Of course, the usual assumption of a numeraire good is made.

13. There are often multiple equilibria in such models as a result of the usual bootstrapping phenomena associated with expectations. That is, there may be many expectations that are consistent in the sense of being self-fulfilling. It remains possible, however, to do comparative statics by choosing any one of these, since they are locally unique.

14. A firm is said to regard its product as a strategic substitute (complement) for its competitors if more aggressive behavior by its rival lowers (raises) the marginal profitability of more aggressive behavior by itself.

15. The assumptions made in fig. 11.1 ensure that the equilibrium is unique. There may in general be many fulfilled-expectations equilibria. There are usually only a finite number of these, which ensures local uniqueness of an equilibrium.

16. These diagrams are similar to those in Krugman (1984).

17. This is because nonconstant marginal costs can provide another link across markets. See Krugman (1984) for an analysis of such interactions.

18. In addition, when ϵ, and/or R_3 are large enough, the terms multiplying t need not be positive. This must be taken into account as well.

19. As usual, a numeraire good is assumed to exist. Demand arises from utility maximization subject to a budget constraint. Also, all profits and tax revenues are returned to consumers in a lump sum manner.

20. It is assumed that $P_3[0, x^*, e(x + y)] = 0$, which is reasonable since if no units are purchased, there is no reason to value increments in network size.

21. See Baldwin and Krugman (1986).

22. See Krugman (1985) for a model that shows how comparative advantage can be "made."

23. Baldwin and Krugman (1986) argue that this was destructive even in the Japanese case.

24. Recent work by Grossman and Shapiro (1986) is a step in this direction.

25. See, for example, David (1984).

26. See Farrell and Saloner (1985) for a model that addresses such inertia.

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