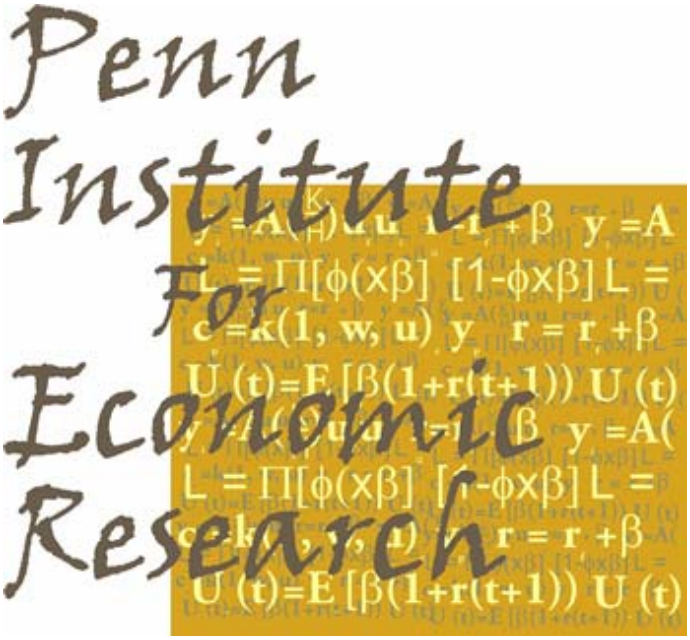

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"Protectionism and Increasing Returns with Comparative-Cost Disadvantage"

by

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PROTECTIONISM AND INCREASING RETURNS WITH COMPARATIVE-COST DISADVANTAGE

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PROTECTIONISM AND INCREASING RETURNS WITH COMPARATIVE-COST DISADVANTAGE

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Abstract: We reconsider the economics of protection with an industry subject to increasing returns. Under strong comparative disadvantage in one country, any tariff-distorted equilibrium in which both countries produce the commodity must be unstable. In general, under strong comparative disadvantage, the case for free trade is greater than without increasing returns. Also, exceptionally high tariffs are required to protect a high-cost increasing-returns industry. Beneficial tariffs or subsidies for the country with comparative *disadvantage* become prominent when the country with a comparative *advantage* faces a relevant capacity constraint.

Keywords: increasing returns, protection, comparative-cost disadvantage, flexible capacity.

***JEL* Classification Codes:** F12, F13

PROTECTIONISM AND INCREASING RETURNS WITH COMPARATIVE-COST DISADVANTAGE*

That economies of scale[1] could well render free trade inadvisable for a country is an old idea in economics, going back at least as far as Graham (1923). Viner (1937, p 473) writes, "It has frequently been claimed by economists that if a country has a comparative advantage in costs in an industry subject to increasing costs . . . and has a comparative disadvantage in an industry . . . subject to decreasing costs, it may not be to the interest of this country to specialize in accordance with comparative costs." See also Irwin (1996). This paper calls such claims into question.

I. Introduction

Many general equilibrium models with increasing returns in one industry have examined free trade only between two *identical* countries (e.g., Melvin, 1969; Panagariya, 1981; Ethier, 1982; Helpman, 1984). Who has not seen the familiar "bowed-in" production

* We thank Douglas Irwin, Ronald Jones, Kieth Maskus, Albert Schweinberger, and participants in a festschrift conference for Ehsan Choudhri at Carleton University for helpful comments.

[1] Antweiler and Trefler (2002) and Caballero and Lyons (1990) present evidence of the practical importance of internal and external scale economies respectively.

possibility curve shared by two countries found in so many textbooks (*e.g.*, Salvatore, 2004, p. 169) and some articles (*e.g.*, Melvin, 1969)? Graham (1923) pioneered the study of protection of an increasing-returns industry with two different countries, but used cumbersome numerical examples. Ethier and Ruffin (2009) analyzed a simplified general equilibrium model of two different economies with economies of scale, and provided a taxonomy of the possible outcomes as functions of the parameters. This paper explicitly examines the role of tariffs and addresses the classical question of whether increasing returns provide an argument for protection.

Throughout we make the assumption of average-cost pricing adopted in the vast majority of the literature.[2] It is widely recognized that with prices above average costs, the possibility of profit-shifting between countries introduces strategic considerations with conflicting policy consequences (Eaton and Grossman, 1986). Thus, for clear-cut results, the assumption of average-cost pricing is necessary. Average-cost pricing is compatible with either economies of scale external to the firm but internal to the industry, or with internal economies of scale with perfectly free entry and exit. We show that the assumption implies that tariffs will normally have to be exceptionally high to protect a domestic industry subject both to increasing returns and a comparative-cost disadvantage, an implication that can be used to test indirectly the assumption of average cost pricing.

We argue that under this assumption the case for free trade is actually *stronger* with increasing returns. We show that the most serious multiple equilibria outcomes conducive to beneficial tariffs or subsidies for the country with a comparative-cost *dis*advantage hinge on the existence of capacity constraints in the country with a comparative advantage. With capacity constraints there may be four distinct possibilities, three of which involve one of the countries possibly being better off at autarky and one of which involves both countries being better off with free trade. Identifying these possibilities in practice may be difficult. Without these capacity constraints, the infant-industry case for temporary tariffs or subsidies in the country with a comparative advantage depends on certain parameters of nation-wide external economies of scale.

The focus of the literature dealing with increasing returns and the gains from trade has been on whether trade increases the output of such goods relative to goods that are produced under constant or decreasing returns (Graham, 1923; Tinbergen, 1945; Kemp,

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[2] Graham (1923), Jones (1968), Kemp and Negishi (1970), Eaton and Panagarya (1979), Panagariya (1981), Ethier (1982), Helpman (1984), Helpman and Krugman (1985, Ch. 5), Matsuyama (1991), Kemp and Schweinberger (1991), and Ethier and Ruffin (2009) all make the assumption of average-cost pricing. For yet another variation, see Grossman and Rossi-Hansberg (2010).

1969; Negshi, 1972; Kemp and Schweinberger, 1991). Negishi (1972) calls this the Graham-Tinbergen proposition: *Welfare rises or falls as trade causes the output of goods produced under increasing returns to rise or fall.* But the literature is in an unsatisfactory state (Helpman, 1984; Kemp and Schweinberger, 1991).

First, such theorems are generally single-country theorems dealing with the opening of trade without specifying world demand conditions or stability; second, they generally ask what happens when the terms of trade improve (Eaton and Panagariya, 1979), but with increasing returns the move from autarky to free trade could lower the price of the exported good. Ethier (1982) showed that if two countries produce the good under free trade, the equilibrium must be unstable. We now show that tariffs do not change this result, but capacity constraints do.

Section II presents the basic analytic framework. Section III then introduces the topic by (1) distinguishing between internal and external returns to scale, (2) arguing that Marshallian stability is the appropriate dynamic adjustment assumption, and (3) displaying the basic economics of free trade between two different countries under increasing returns. Section IV examines the stability of a tariff-distorted equilibrium and shows that it will generally be unstable if both countries produce the good, just as in Ethier (1982). Section V then argues that the case for free trade is stronger with economies of scale, especially if there are international external economies or internal economies. This section also defines the prohibitive tariff under increasing returns, and shows that it is higher than any cost-equalizing "scientific" tariff. In contrast to standard tariff theory, any tariff less than prohibitive must shut down the domestic industry completely. Any other situation would be unstable. Section VI shows that, if the country with a comparative-cost advantage faces capacity constraints or is sufficiently small, three stable equilibrium outcomes where tariffs may be beneficial are possible. Capacity constraints turn the economics of protection under comparative-cost disadvantage upside down and Graham-Tinbergen may emerge. Section VII allows for flexibility in the capacity constraint.

II. The Model

Assume two countries (Home and Foreign), three factors (*C*apacity, *K*apital and *L*abor), and 2 traded goods (*0*, *1*). Good *0* is a numeráire good, produced by labor alone. Good *1* is produced by capacity, capital and labor, with capacity and capital specific to this sector. Choose units so that a unit of good *0* is produced by a unit of labor. Thus, assuming good *0* is actually produced, the wage $w = 1$.

If C and K denote the available quantities of capacity and capital, the labor required to produce x units of good *1* is given by

$$F(x, K) \equiv xf(x, K) \equiv x\,c(x), \qquad x \le C,$$

with K subsumed in the functional form of $c(x)$. Production of x is characterized by increasing returns to scale: $c'(x) < 0$. Production in Foreign is similar, with the labor required to produce x^* units of good *1* given by $x^*c^*(x^*)$, $x^* \le C^*$. (We use asterisks to denote Foreign values). To draw a sharp distinction between the countries, we assume that Foreign has a strong comparative advantage in good *1* in the sense that $c(z) > c^*(z)$ for *any* common output z.

In each country individual preferences are summarized by the utility function

$$U = c_0 + u_1(c_1)$$

where c_i respectively denotes consumption of the two goods. This implies individual demand functions $d = d(P)$, where P denotes the domestic relative price of good *1* in terms of good *0*. Residual income is all spent on the numeráire good *0.* We assume that endowments in both countries are such that each both produces and consumes good *0*. Then an individual's utility can be expressed in the indirect form

$$v(P\ ,\ y) = s(P) + y \qquad \textbf{(1)}$$

where $s(P) = u(d(P)) - P\,d(P)$, the consumer surplus derived from good *1*, and y denotes the individual's income. We assume, realistically, that consumers do not include tariff revenue in their welfare expressed in **(1)**. Define aggregate consumer surplus

$S(P) = Ls(P)$ and aggregate demand $D(P) = Ld(P)$, where L denotes the number of households (= labor force).

Equilibrium in the world market for good *1* when Home imports that product is represented by

$$M(T + P^*) = X^*(P^*) \quad \textbf{(2)}$$

where M and X^* respectively denote Home import demand and Foreign export supply of good *1*, P^* its relative price in Foreign and T Home's specific tariff. The latter thus determines P^*, independently of the other sector (allowing the use of partial equilibrium techniques). Trade balance is reached with a net exchange of good *0*.

III. The Economics of Economies of Scale

This section argues that with either internal or external increasing returns to scale the appropriate stability concept is that output adjusts to the difference between demand and supply prices (Marshallian dynamics). We also establish a version of the Graham-Tinbergen theorem as a corollary to such stability.

1 *External versus internal economies*

External economies basically mean that a firm's costs are lower because of the size of the industry in which it operates. Alfred Marshall laid out the basic economics of external economies (Marshall, 1920, Book IV, Ch. X). Paul Krugman's Nobel Prize lecture compactly summarized Marshall: External economies exist because of knowledge spillovers, labor-market pooling, and specialized capital inputs (Krugman, 2009).

With internal economies of scale there is a single firm with total costs $x\,c(x)$ and marginal cost $\equiv MC = c(x) + x\,c'(x) < c(x)$ as $c' < 0$. One can have an equilibrium with $P = c(x)$ in a contestable market with free entry and exit; a single firm dominates the market. Jones (1968) and Chipman (1970) assumed that with national external economies

of scale, a single firm has total costs $x_i c(x)$, where x_i is the firm's output and x is industry output. If the firm assumes that its output does not affect industry output, then the firm's $MC = AC = c(x)$. At the firm level, the firm has constant returns to scale. Under either scenario, market clearing implies that $P = c[D(P)]$.

It is important whether external economies are *international* or *national* in scope (Ethier, 1979). If international, a firm in the home country has total costs of $x_i c(x + x^*)$, where x^* is Foreign output. This case is very similar to internal increasing returns because with average-cost pricing and free trade, the good will be produced in the country with the lowest average cost instead of the single firm in the country with the lowest average cost.

2 *Autarky stability*

Negishi (1972) and Helpman (1984) have shown that irreversible external economies do not damage the case for free trade. We therefore assume throughout that the external economies are reversible.

Ethier (1982) introduced Marshallian dynamic adjustment for the case of external returns to scale: When the demand price exceeds the supply price, output expands. With external returns, Walrasian stability (price adjustment) would be suggested if each individual firm had upward-sloping MC curves, which are ruled out when firms display constant returns (Jones, 1968; Chipman, 1970). Thus, there is no supply curve in the conventional sense, so for any $P > c(x)$, any firm would simply want to expand output. The same would also hold for internal economies of scale as there is a single firm.

Under Marshallian dynamics, output increases (decreases) if the demand price exceeds (is less than) the supply price (Ethier, 1982). Thus the autarkic stability condition is that the slope of the demand curve be steeper than the slope of the average cost curve. Define the demand price as $P_D(x) = D^{-1}$ and $c(x)$ as the supply price. Marshallian dynamic adjustment can be represented as $dx/dt = P_D - c(x)$. Then the stability condition is just $d[P_D - c(x)]/dx = 1/D' - c' < 0$.

Proposition 1 The autarkic equilibrium is stable if $\Delta \equiv 1 - D'\, c' > 0$.

Obviously, a similar condition would hold for stable free trade if only Home is producing the good.

From a single-country standpoint, with average-cost pricing and no producer surplus, the Graham-Tinbergen proposition is disarmingly simple. For Home, $P = c[D(P) - M]$, where M denotes Home imports. Then $dP/dM = -c'/\Delta > 0$ by the autarkic stability condition. Thus an increase in M causes a rise in P, implying a loss of consumer surplus and thus, by **(1),** a reduction in individual welfare v. For Foreign, $P^* = c^*[D^*(P^*) + M]$, so that more exports lower the domestic price, since $dP^*/dM = c^{*\prime}/\Delta^* < 0$, implying a gain of consumer surplus.

3 *Free trade*

We now establish a series of propositions that broadly show the linkages between the various concepts of increasing returns and the free-trade equilibrium outcomes. A minor case of temporary subsidies arises in one situation, but in all cases every country is better off if the low-cost country provides all of the good. There is no case for permanent protection as long as the average cost curves of good *1* are downward-sloping in both countries.

World demand is $D^o(P) = D(P) + D^*(P)$. Define $D^o[c(x)] = x_F$ and $D^o[c^*(x^*)] = x_F^*$ as the potential free-trade levels of output with one country supplying the entire world demand. Denote $c^*(x_F^*) = P_F^*$ as the *non-reversal equilibrium* and $c(x_F) = P_F$ as the *advantage-reversal equilibrium*: The world market for good *1* is served entirely by the high-cost Home industry. These equilibrium outcomes are illustrated in Figure 1 by points F and F^* respectively. To avoid clutter, Figure 1 assumes $D = D^*$ and the curves are depicted as linear. P^A and P^{A*} denote the respective autarky equilibrium prices.

With internal returns or international external returns to scale, at the advantage reversal equilibrium F, entry will occur in the foreign country since $P_F = c(x_F) > c^*(x_F)$. This proceeds until P falls to $P_F^* = c^*(x_F^*)$.[3] The advantage reversal equilibrium F is unstable and F^* is stable.

[3] See Helpman and Krugman (1985, p 71).

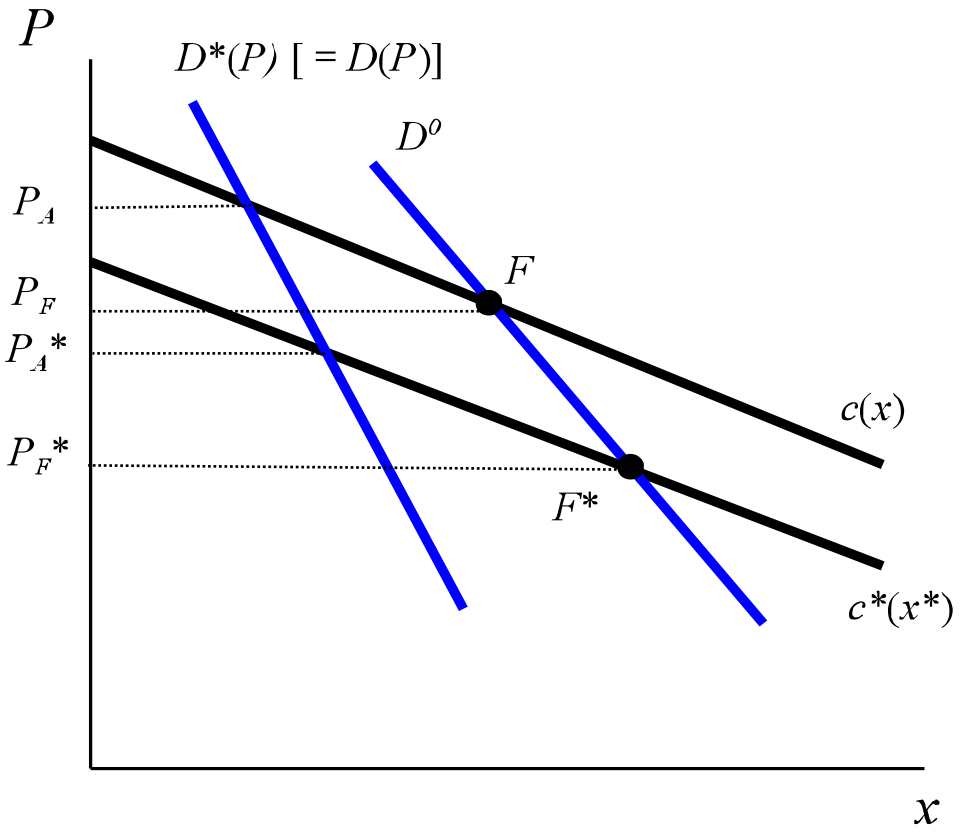

Figure 1 Autarky and Free Trade

However, with national external economies of scale, $P_F = c(x_F)$ is stable as long as $P_F < c^*(0)$, as in Figure 1. Thus, under that condition, both $P_F = c(x_F)$ and $P_F^* = c^*(x_F^*)$ are stable equilibria. Notice, however, that the foreign country can be worse off in the advantage-reversal situation because it is possible for $P_F > P_A^*$, where $D^*(P_A^*) = x_A^*$ and $c^*(x_A^*) = P_A^*$, the autarky price in the foreign country, as illustrated in Figure 1.[4] The home country is better off in either the advantage-reversal equilibrium or the non-reversal equilibrium. Summarizing:

Proposition 2 With national external economies of scale, there are stable free-trade equilibria in which either the country with a comparative advantage or that with a disadvantage supplies the entire market. If the country with a comparative disadvantage supplies the world market (the advantage-reversal outcome), the other country may be worse off than in autarky. Both countries are better off in the non-reversal equilibrium outcome.

Proposition 3 With internal economies of scale or international external economies, only the free-trade equilibrium in which the country with a comparative advantage supplies the entire market is stable. Both countries are better off than in autarky.

With national external economies, where perhaps a historical accident has the comparative-disadvantage country producing good *1*, the other country can use a temporary tariff or subsidy to make both countries better off by a regime change (Ethier and Ruffin, 2009). But there is no case for permanent protection.

[4] Helpman (1984) shows that this is unrealistic in the Ethier (1982) example of general equilibrium between two identical countries; but Figure 1 shows that it is probably more likely than suggested by the functional forms chosen by Helpman and Ethier.

IV. A Tariff-Distorted Production Equilibrium is Unstable

This section applies the stability analysis in Ethier (1982) to the case of a tariff-distorted equilibrium in which both countries produce good *1*. We now rule out international external economies of scale. There is a specific tariff T on each unit of the good imported into, say, the home country. The analysis does not depend on which country has a true comparative advantage, so it could conceivably apply to the case of external returns to scale with the high-cost home country exporting the good.

1 *An unstable equilibrium*

Consider a market clearing for some pair (x, x^*):

$$D^o(P, P^*) = D^*(P^*) + D(P) = x + x^* \qquad \textbf{(3)}$$

with $P = P^* + T$. In our dynamic analysis we are assuming that markets clear at every instant and that there are no arbitrage profits. Following Ethier (1982), we can solve for the demand prices

$$P_D = H(Q, T) \text{ and } P_D^* = H^*(Q, T) \qquad \textbf{(4)}$$

where $Q = x + x^*$. Note that the derivatives are $\partial H/\partial x = \partial H^*/\partial x^* = 1/D^{0\prime} = 1/(D^{*\prime} + D^{\prime})$ because of perfect arbitrage. With Marshallian adjustment mechanisms each output rises per unit time if its demand price exceeds its supply price. If the industry is producing in both countries, the respective supply prices are $c(x)$ and $c^*(x^*)$. This holds for both internal returns to scale and national external returns. Thus we specify the adjustment mechanisms:

$$dx/dt = a_1 \equiv H(x + x^*, T) - c(x) \text{ and } dx^*/dt = a_2 \equiv H^*(x + x^*, T) - c^*(x^*). \qquad \textbf{(5)}$$

Ethier (1982) refers to $a_1 = 0$ and $a_2 = 0$ as allocation curves. Define:

$$a_{11} = \partial H/\partial x - c \; = 1/D^{0\prime} - c' \; ; \qquad a_{12} = \partial H/\partial x^* = 1/D^{0\prime};$$

$$a_{22} = 1/D^{0\prime} - c^{*\prime}; \qquad a_{21} = 1/D^{0\prime}.$$

We now show that $a_1 = a_2 = 0$ is not a stable equilibrium.

Figure 2 measures home country output horizontally and foreign country output vertically. Just as in Ethier (1982), *if* $a_1 = 0$ is flatter than $a_2 = 0$ then the equilibrium E is unstable. If Home increases the tariff, its allocation curve ($a_1 = 0$) shifts to right; and Foreign's allocation curve shifts to the left. To understand the relative slopes of these curves keep in mind that, as x or x^* changes, the price changes in the same direction by a larger amount than average costs, since the demand curve is steeper than the average cost curve. Thus, imagine a movement southeast down $a_2 = 0$ where $P^* = c^*$. It is necessary for P^* to be higher since x^* is lower and, therefore, P to be higher because of arbitrage. Thus, $P > c$ because x is larger. To reach $P = c$, we must increase x more for P to fall to c, so that $a_1 = 0$ is flatter, and therefore E is unstable.

Mathematically, the absolute slope of $a_1 = 0$ is $a_{12}/a_{11} = 1/(1 - D^{0\prime}\, c')$ and the absolute slope of $a_2 = 0$ is $(1 - D^{0\prime}\, c^{*\prime})$. Stability requires that $(1 - D^{0\prime}\, c')(1 - D^{0\prime}\, c^{*\prime}) > 1$. But our condition for autarkic stability implies that $1 > (1 - D^{0\prime}\, c')(1 - D^{0\prime}\, c^{*\prime})$). Thus:

Proposition 4 There is no stable tariff-distorted equilibrium in which both countries produce good *1* with either nation-wide external or internal economies of scale.

Note that this holds for *any* situation in which both countries produce commodity *1* with a tariff.

2 *A stable equilibrium*

The above discussion examined an "interior" solution. If there is a corner solution, with Foreign producing at capacity C^*, that equilibrium would be stable, since $c^{*\prime} = \infty$. This is illustrated in Figure 2 where the capacity constraints truncate the allocation curves, and where at E^1 the foreign country is capacity constrained. This is a stable equilibrium. There could be multiple stable equilibria: For example, the two curves could intersect with the home country capacity constrained.

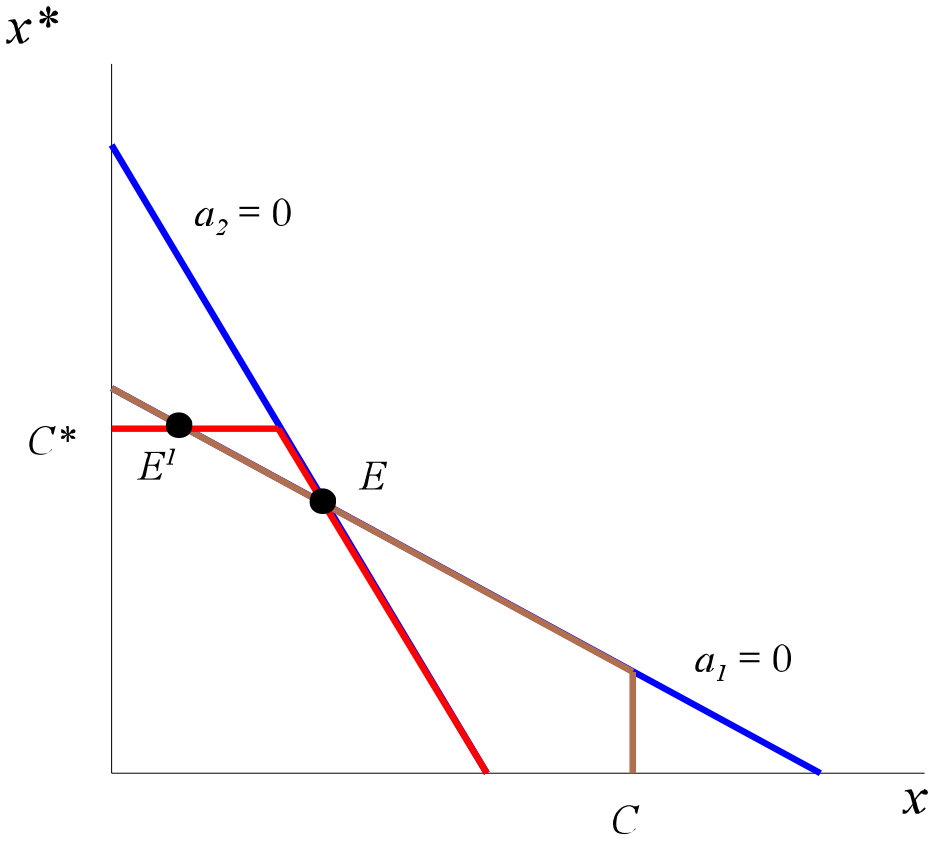

Figure 2 Stable and Unstable Equilibria

V. The Case for Free Trade Can Be Stronger with Scale Economies

We have shown that if each country can individually supply world demand any stable trading equilibrium would feature complete specialization by one of the countries. Now examine in more detail the case where Home does not produce good *1*.

1 *The height of protective tariffs*

The theory of tariffs under increasing returns differs significantly from the standard theory of tariffs. In standard theory, a tariff improves the terms of trade of a large country; in the present case a tariff worsens the terms of trade. In standard theory, the difference in autarky prices measures the prohibitive tariff; here a prohibitive tariff would occur where autarky yields more direct consumer utility than importing.

Autarky is defined as $D[c(x_A)] = x_A$. Consider a tariff on foreign imports high enough so the imported price equals the home autarkic price:

$$D(P^* + T) + D^*(P^*) = x^*,$$

$$P^* = c^*(x^*),$$

$$c(x_A) = P^* + T.$$

This tariff satisfying these equations is just prohibitive, and we label it T_A. The first two equations represent the intersection of the tariff-distorted world demand curve with $c^*(x^*)$. (See Figure 3). This level of x^* exceeds x_A^*, Foreign's autarky output, because Home is importing all its requirements from Foreign. So $P^* < c^*(x_A^*)$, and thus when the third equation holds, we must have $c(x_A) < c^*(x_A^*) + T_A$, that is, T_A exceeds the difference in autarky prices.

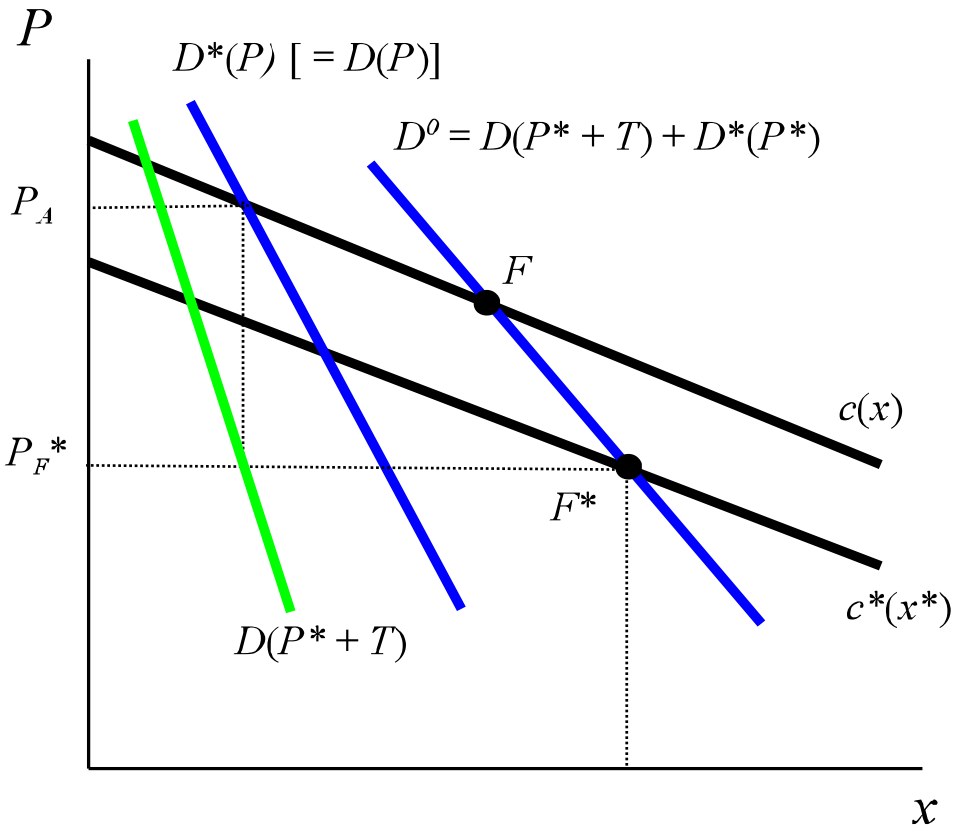

Figure 3 A Just-Prohibitive Tariff

For any $T < T_A$, the tariff-distorted world demand curve would be higher, causing a further reduction in P^* and the complete shut down of the Home good-*1* industry. Of course, if $T > T_A$, autarky prevails. Since $T_A > c(x_A) - c^*(x_A^*)$, the just-prohibitive tariff may substantially exceed the difference in autarky prices, with the same demand conditions in Home and Foreign. Exceptionally high tariffs are required to protect high-cost increasing returns-to-scale industries in which countries have comparative disadvantages.

These results gain possible importance from a survey (Tybout, 2000) of studies of many developing countries concluding that firms exhibiting economies of scale seem rare. This relative absence may indicate the difficulty of using tariffs to protect them from larger-scale firms in developed countries.

2 *The case for lowering tariffs*

With a tariff $T < T_A$, we have $D[c^*(x^*)+ T)] + D^*[c^*(x)^*] = x^*$. Thus, any increase in the tariff results in:

$$dx^*/dT = D' /\Delta^{*o} < 0 \qquad \textbf{(6)}$$

where $\Delta^{*o} = 1 - D^{o\prime}\, c^{*\prime} > 0$ since the world demand curve intersects c^* from above. The impact on the domestic price is:

$$dP/dT = dP^*/dT + 1 = c^*\ (dx^*/dT) + 1 > 1 \qquad \textbf{(7)}$$

Moreover, since imports equal $M = D(P)$, $dM/dT = D\ (dP/dT) < 0$.

Now consider welfare analysis. Social welfare is:

$$W = S(P) + \ TD(P). \qquad \textbf{(8)}$$

Note that the government, unlike individual households, takes the tariff revenue into account.

In this case, imports $M = D(P)$. Accordingly,

$$dW/dT = D(P)(1 - dP/dT) + TdM/dT. \qquad \textbf{(9)}$$

Then $dW/dT < 0$, since $dP/dT > 1$ and $dM/dT < 0$. Welfare continuously diminishes from free trade to autarky! The intuition is that the tariff increases the domestic price more than the increase in the tariff itself because foreign costs now rise and so swamp any beneficial tariff revenue effect. The case for free trade is stronger in the presence of scale economies.

Proposition 5 If the high-cost country is importing, under a non-prohibitive tariff, a good subject to increasing returns in the low-cost country, any reduction in that tariff will benefit both countries.

VI. The Case for Tariffs or Subsidies

If the high-cost Home produces good *1* due to national external economies and historical accident, the low-cost Foreign could impose a temporary subsidy to switch production from Home to Foreign. This new equilibrium would be superior for both countries. We saw above that if Foreign faces a capacity constraint, there is the possibility of a stable equilibrium in which both countries produce the good. This section explores the consequences of this fact for protection. The additional case of Home being capacity constrained is analogous and will be left to the dedicated reader.

1 *Multiple free-trade outcomes*

Assume that Foreign meets a capacity constraint at C^*, but that up to that point $c(x) > c^*(x)$. The capacity constraint could be due to a small country size, as in Ethier and Ruffin (2009), or due, more broadly, to the lack of backward linkages in an undeveloped country with a history of protectionism, war, or revolution.

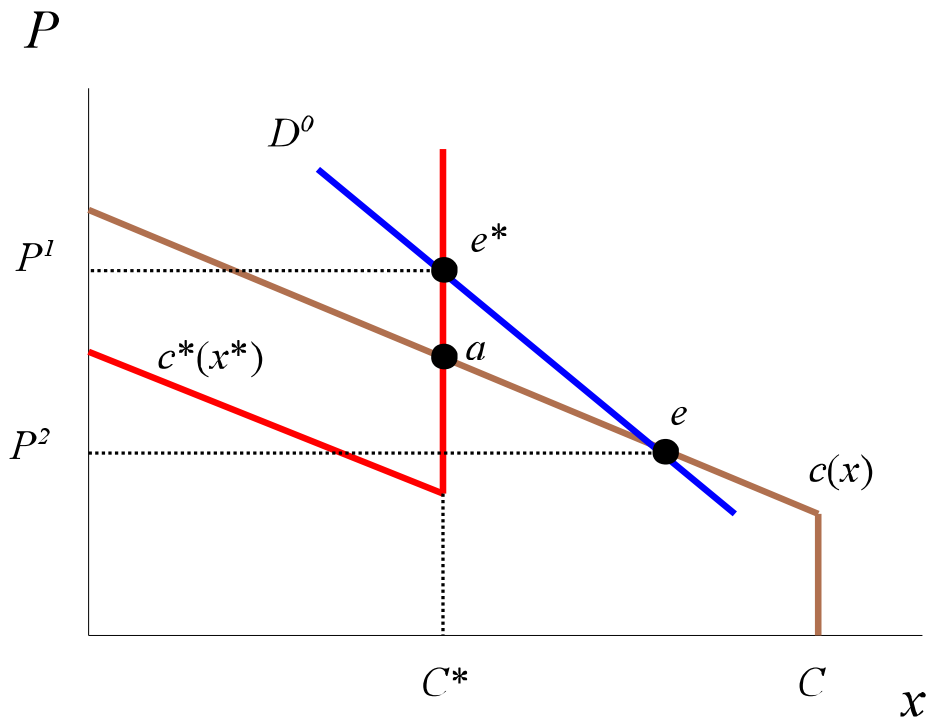

Figure 4 Multiple Equilibria

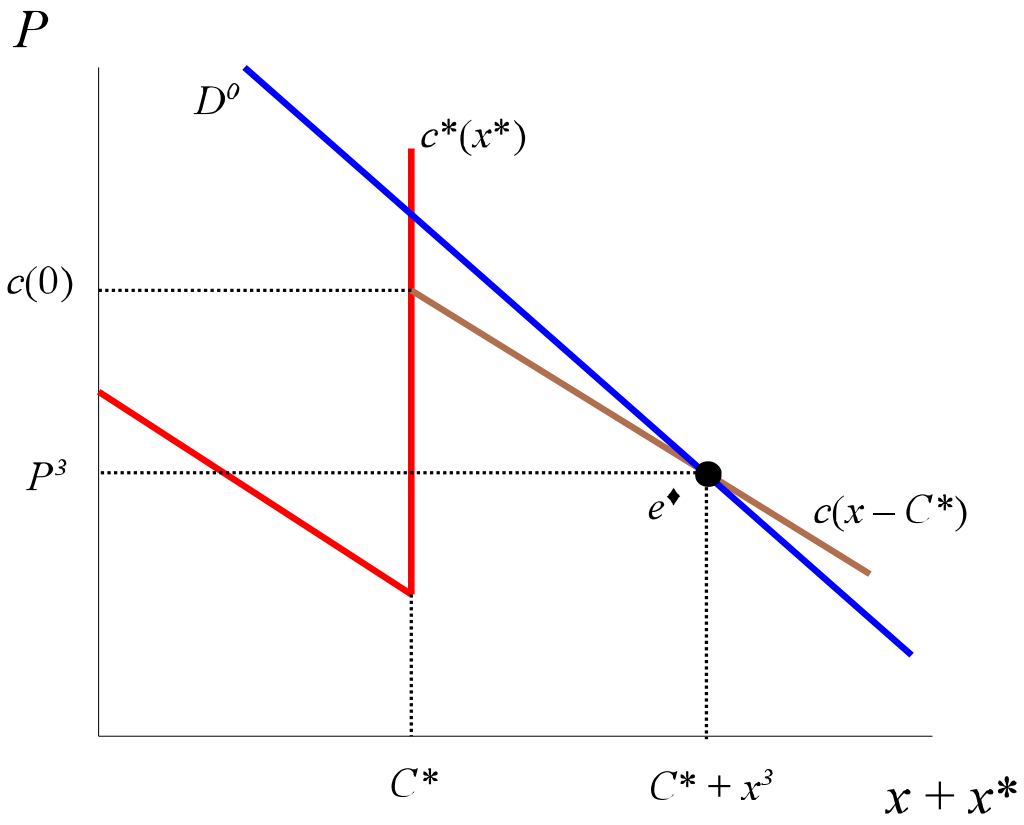

Figure 5 Production in Both Countries

Now consider the world demand curve D^o in Figure 4 with national external economies. Figure 4 shows that, had the world demand curve intersected the cost curve $c(x)$ *below* point a and above the minimum of $c^*(x^*)$, both countries would be better off in the free-trade solution $D^o(P^1{}^*) = C^*$ because Home buys the good cheaper than in autarky and Foreign receives rents (in the form of a positive return to C^*). Thus, we ignore this case as it is similar to Figure 1's solution F^*.

Then, in Figure 4, the world demand curve passes *above* point a, so there are three possible equilibria: e^*, where only Foreign produces good *1*; e, where only Home produces it; and a third (shown separately in Figure 5) where both countries produce the good. We summarize.

Proposition 6 Suppose good *1* is produced under national, external increasing returns to scale. Define P^1 by $C^* = D^0(P^1)$. Then, if $c(0) > P^1 > c(C^*)$, we have the following equilibria.

$$D^o(P^1) = C^* \qquad \textbf{(}\boldsymbol{e}^*\textbf{)}$$

$$D^o[c(x^2)] = x^2 \qquad \textbf{(}\boldsymbol{e}\textbf{)}$$

$$D^o[c(x^3)] = x^3 + C^*. \qquad \textbf{(}\boldsymbol{e}^\blacklozenge\textbf{)}$$

Denote $P^2 = c(x^2)$ and $P^3 = c(x^3)$. Then $P^1 > P^3 > P^2$.

$P^3 > P^2$ because Home produces less of the good in equilibrium **(**$\boldsymbol{e}^\blacklozenge$**)** than in equilibrium **(*e*)**, and thus moves up its average cost curve. Note that if $c(0) < P^1$ the first equilibrium would disappear. We now examine each outcome in turn.

Only Foreign Production ***(e*).*** The equilibrium e^* in Figure 4 is stable provided $P^1 < c(0)$, but Home might be better off in autarky (if P^1 exceeds the autarky price in Home). However, Foreign must be better off in e^*, supplying the entire world market, than in autarky, because it now earns economic rents (a positive return to capacity) as well as consumer surplus.

Only Home Production ***(e)***. The equilibrium e in Figure 4 is better for Home than autarky, and will be stable with $P^2 < c^*(0)$. But, again, Foreign could be better off in

autarky. Below, we examine the possibility of Home granting a production subsidy to prevent Foreign from choosing autarky.

Both produce ***(e♦)***. Finally, the third equilibrium has one solution, but two trade outcomes. This is shown in Figure 5, where $c(x)$ starts at $C^* = x^*$. In other words, x is a function of C^* depending on $D^o(P)$, but $D^o = D(P) + D^*(P)$, so it is possible for $D(P) > x$ or $D(P) < x$. If Home happens to have a low demand for the good, perhaps unlikely, it could be the exporter and would be better off with trade. In this case, where $D(P) < x$, Foreign is also better off importing good *1* because it is producing at capacity and $D^*(P) > C^*$, but the price will be lower than in autarky because of the supply from Home. Trade does not cause its production to increase, because it can't.

If, on the other hand, $D(P) > x$, then Home is worse off trading because it is producing less of the good than under autarky, and Foreign is better off. In this case the Graham-Tinbergen proposition is in full flower: Home produces less of the increasing-returns good and is worse off with trade. Home would be better off imposing a tariff and increasing its output of good *1* because not only does the price fall, but Home also collects tariff revenue. Autarky generates no tariff revenue, so there is an optimum tariff, assuming no retaliation by Foreign.

2 *A production subsidy*

It is quite possible that under any free trade outcome, one of the countries is better off with autarky. So consider the two countries being at loggerheads and stuck at autarky. Now imagine the larger country, say Home, decides to impose a subsidy on the production[5] of good *1*. In the following equilibrium, Home grants a production subsidy of r per unit such that Foreign is just as well off in autarky, $c^*(x_A^*)$, as importing all of its requirements from the larger Home:

$$D^o[c(x) - r] = x \qquad \textbf{(13)}$$

$$c(x) - r = c^*(x_A^*) \qquad \textbf{(14)}$$

[5] The reader is invited to consider an export subsidy.

These two equations solve for x and r as functions of x_A^*. Home will be better off than in autarky provided

$$S[c^*(x_A^*)] > S[c(x_A)] + rx. \quad \textbf{(15)}$$

This condition need not be satisfied if $c^*(x_A)$ is too small relative to $c(x)$ because the necessary subsidy rises faster than consumer surplus. Under condition **(15)**, subsidized production by the large country (Home) is appropriate. Of course, a slightly larger subsidy would also improve the position of the smaller country (Foreign) compared to autarky.

VII. Flexible Capacity

Thus far we have taken capacity as exogenously given and quite inflexible. As we are not considering growth, we take the overall asset position of each country's good-*1* sector as given, but it's unrealistic to view capacity as completely rigid. So assume that the sector can substitute between K and C, that is, it can expand capacity by increasing production costs. Specifically, we assume

$$K^0 = K + C. \quad \textbf{(16)}$$

Such flexibility can be practiced by the individual firm and is independent of the nature of the economies of scale. We now write the Foreign average-cost function as

$$c^* = \gamma(x^*, K^0 - C^*)$$

where $\gamma_1 < 0$ and $\gamma_2 < 0$.

In equilibrium a firm will not choose to maintain useless excess capacity, so an equilibrium condition is

$$c^* = \gamma(x^*, K^0 - x^*)$$

where $x^* \leq K^0$. To maintain decreasing average costs, we assume

$$c_1^{*\prime} \equiv (dc^*/dx^*) = \gamma_1 - \gamma_2 < 0.$$

Basically, $c_1^{*\prime}$ replaces $c^{*\prime}$ in the earlier discussions, and clearly $0 > c_1^{*\prime} > c^{*\prime}$. We investigate the consequences in two cases.

To give the flavor of how flexible capacity matters, we discuss how it affects the case of only foreign production, in Subsection 1 of Section VI (Multiple Free-Trade Outcomes). Other cases are left to the reader.

Figure 6 shows how Figure 4 is altered in the presence of flexible capacity in Foreign. The dashed curve corresponds to $c^*(x^*)$ in Figure 4, and the solid curve depicts the case with flexible capacity. It is evident that the free-trade equilibrium at e_1^* features more consumer surplus for both countries, and less rent for Foreign capacity, than does e^*.

To summarize:

Proposition 7 The presence of flexible capacity results in more consumer surplus and a lower Foreign capacity rent in the free-trade equilibrium in which only a capacity-constrained Foreign produces good *1*.

We leave to the reader to work out the consequences of flexible capacity in other circumstances.

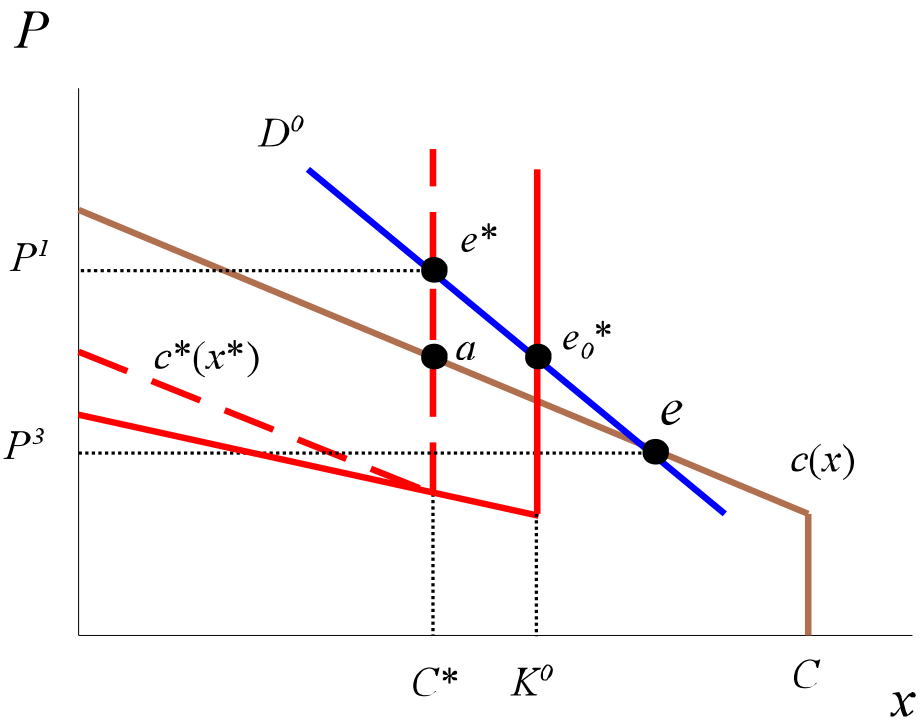

Figure 6 Flexible Capacity

VIII. Conclusion

We have argued that with either external or internal returns to scale, the country with a strong comparative disadvantage in a good is better off if it imports all of its requirements from the other country simply because the price is cheaper. Generally speaking, a tariff imposed by a high-cost country will always hurt both countries because the price rises in the exporting country and rises by even more in the importing country, swamping any revenue effect. Such a tariff will not invigorate the domestic industry unless it is higher than any cost-equalizing scientific tariff.

As in Ethier (1982), for any free trade equilibrium between identical countries and diversified production, a tariff-distorted equilibrium with positive outputs and decreasing average costs in both countries must be unstable if there is autarkic stability. The equilibrium will be stable if one country is at capacity or one country is the only producer.

Beneficial tariffs or subsidies become prominent for the technologically-disadvantaged country when the country with an initial comparative advantage faces a capacity constraint (presumably a small country). While such cases may be unrealistic, with national external economies of scale there are four possible free-trade outcomes, but in three of the outcomes autarky may be better for one of the countries. Should it happen that the small country with such an initial advantage is producing at capacity and the large country imports the good, the large country can gain from a tariff. There is an optimum tariff in this case. Another possible outcome that could avoid an autarky-inducing tariff war would be the large country supplying the entire world market by providing a subsidy (production or export) to its increasing-returns industry, though this can prove too costly if the autarkic price in the small country is too low. Notice that there is no case for a permanent tariff or subsidy for a small country with an initial comparative advantage, only for a large country with a size-induced comparative advantage. Flexible capacity has a quantitative impact on some of our analysis, but it does not alter the basic conclusions.

The difficulties faced by a government attempting to identify candidates for industrial policy are widely appreciated (Scott Callon, 1995). We see here one of the reasons: There are too many possibilities for an information-constrained policy-maker adequately to address. As a wizened old economist once said, “protection might procure economic

advantage in certain cases, if there was a Government wise enough to discriminate those cases, and strong enough to confine itself to them; but this condition is very unlikely to be fulfilled" (Edgeworth, 1894, p. 48). However, nothing here precludes these cases from being identified by the industry itself, such as the subsidies provided to biotechnology companies by large drug companies. General Motors, after World War II, helped Fiat arrange private financing to keep the company afloat because of its long associations with Fiat.

But times do change. General Motors spent billions to back out of further involvement with Fiat. And Edgeworth, still wizened, is now quite dead.

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