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Network Effects and the Impact of Trade Liberalization

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Abstract

In this note, we examine how trade liberalization affects the profits of firms in the presence of network effects. We will show that, contrary to conclusions in the previous literature, trade liberalization between identical countries *increases* firms' profits despite intensified competition.
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1 Introduction

The proliferation of trade liberalization through both economic integration (e.g., the European Union) and preferential trade agreements (e.g., NAFTA) has spawned a vast literature on the implications of trade liberalization. As yet, however, little attention has been paid to the implications of trade liberalization in the presence of products with network effects.

A product that creates network effects generates some of its value through compatibility with other products of the same type. Fax machines, computer software, video cassette recorders, and automobile parts are familiar examples. The network value of the good takes the form of an externality which is a function of the volume of the product in use. Despite the fact that many industries characterized by network effects are crucially related to trade liberalization, the literature on network effects is almost exclusively focused on closed economies.[1] Since the role of network effects is amplified in the globalized world, it seems important to explore the impact of liberalization in the trade of products with network effects.

As our primary contribution, we examine how trade liberalization affects the profits of firms in the presence of network effects, which also helps to explain the international coordination of standards. For these purposes we construct a simple two-country oligopoly model of trade with network effects.

In regard to the impact of trade liberalization, Anderson et al. (1989, p. 730) shows that, in the context of an oligopoly selling a homogeneous product, all firms must lose from trade liberalization if both countries are identical in terms of the number of firms and the level of demand.[2] This implies that firms may be reluctant to accept international competition. In contrast, we will show that all firms might gain from trade liberalization due to intensified network effects.

[1] See Katz and Shapiro (1994), Economides (1996a), Shy (2001) for surveys of the relevant closed-economy literature. For the open-economy context, see Gandal and Shy (2001), Barrett and Yang (2001), and Kikuchi (2003, 2005).

[2] See, also, Brander (1981) and Markusen (1981).

In the next section we present the basic model. The impact of trade liberalization is considered in Section 3.

2 The Model

Suppose that there are two countries in the world: Home and Foreign. There is a Home monopolist, who is the exclusive holder of a particular technology, and $n-1$ Foreign firms, who are potential holders of that technology.

First, let us describe the Home autarky (monopoly) equilibrium. Suppose that the *expected* volume of sales in the market is S. Let the network effect function $f(S)$ measure the increase in the aggregate willingness to pay because of the network effects. It is assumed that both $f(0) = 0$ and $f'(S) \geq 0$. Given expected sales of volume S, let the aggregate willingness to pay for quantity Q increase from $P(Q;0)$ to $P(Q;S) = P(Q;0) + f(S)$.[3]

Assume that Home's inverse demand function before the market integration is as follows:

$$\begin{aligned} P &= a - (Q/m) + f(S), \\ 0 &< m < 1, \end{aligned} \tag{1}$$

where Q is the equilibrium quantity supplied and m $(1-m)$ measures the relative size of the Home (Foreign) market. If demand is the same in each country, $m = 1/2$ holds.

In the monopoly case, the profit of $\Pi = qP(q;S)$ is maximized by choosing q . In this case, the autarky market size of Home, S^A, becomes

$$S^A = m[a + f(S^A)]/2, \tag{2}$$

where superscript A indicates the autarky equilibrium. Note that $q^A = Q^A = S^A$ holds at the monopoly equilibrium. Thus the equilibrium profit for the Home monopolist becomes

$$\Pi^A = m[a + f(S^A)]^2/4. \tag{3}$$

[3]See Economides (1996b, pp. 215-216) on the restrictions on $f(S)$.

Now consider the trading equilibrium: trade liberalization allows competition into the market and results in an n-firm symmetric Cournot oligopoly.

The industry demand function for the integrated market is[4]

$$P(Q;S) = a + f(S) - Q. \tag{4}$$

Firm i chooses q_i to maximize $\Pi_i = q_i P(Q;S)$, where $Q = q_i + \sum_{j \neq i} q_j$. The first-order condition for firm i is

$$a + f(S) - 2q_i - \sum_{j \neq i} q_j = 0. \tag{5}$$

The implied symmetric market equilibrium is

$$\begin{aligned} q_i &= (a + f(S))/(n+1), Q = n(a + f(S))/(n+1), & (6)\\ P &= (a + f(S))/(n+1), \Pi_i = (a + f(S))^2/(n+1)^2. & (7) \end{aligned}$$

At fulfilled expectations, the following condition must hold:

$$S^T = n[(a + f(S^T)]/(n+1), \tag{8}$$

where superscript T indicates a trading equilibrium value. The equilibrium profits of a firm at an n-firm fulfilled expectations equilibrium are

$$\Pi^T = (a + f(S^T))^2/(n+1)^2 = (S^T/n)^2. \tag{9}$$

3 The Impact of Trade Liberalization

This analysis considers the extreme case of moving from prohibitive trade barriers to completely free trade. In other words, we discuss the decision to invite entry by the Home monopolist if, after entry, the resulting competition creates an n-firm symmetric Cournot oligopoly. The Home monopolist's profit will change from Π^A to Π^T. From (3) and (9), this change depends

[4]By combining (1) and its Foreign counterpart ($P = a - [Q/(1-m)] + f(S)$), we can obtain the inverse demand function for the integrated market.

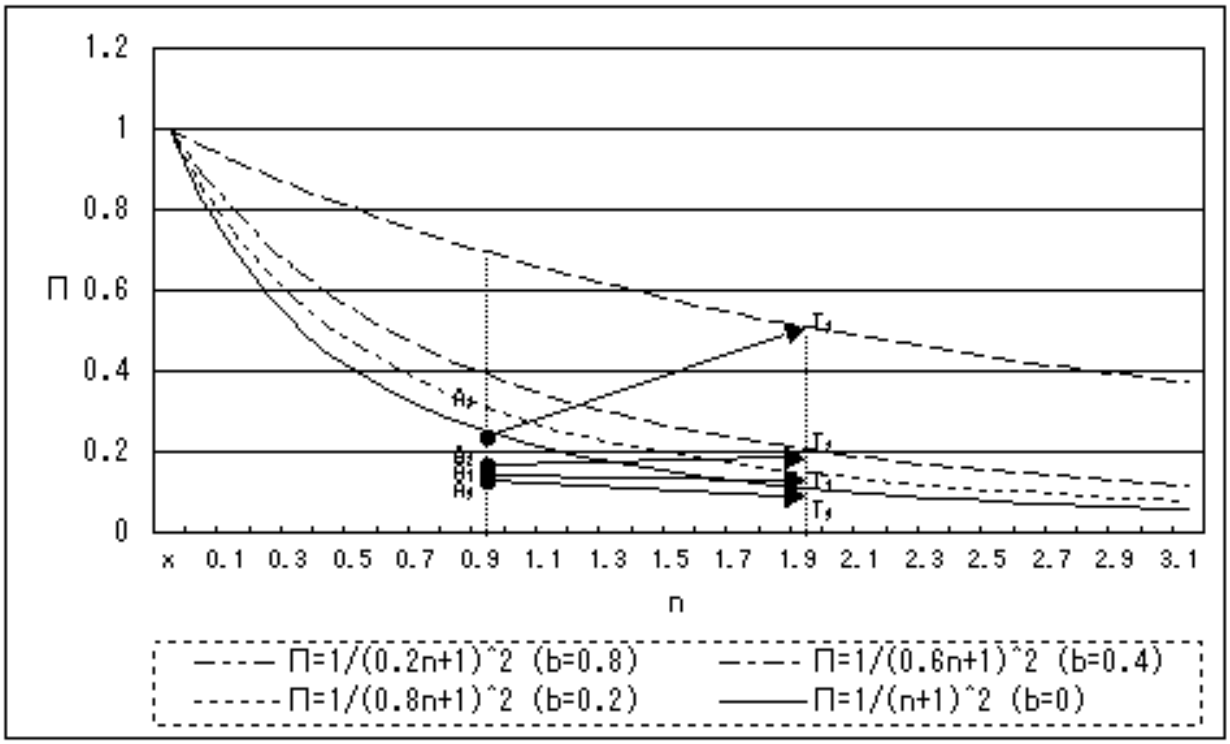

Figure 1

on both the relative Home market size (m) and the number of Foreign rivals ($n-1$).

In what follows, to simplify the analysis, let the network effect function be linear: $f(S) = bS, b < 1$. In this case, $\Pi^A = ma^2/(2-mb)^2$ and $\Pi^T = a^2/[n(1-b)+1]^2$ hold.

As we have shown in the previous section, the equilibrium profits of a firm under trade liberalization are a decreasing function of the number of Foreign firms. This relationship is depicted as downward sloping curves in Figure 1. As the network effect (b) becomes larger, the reduction in profit caused by increased competition will be mitigated.

Proposition 1: *The network effect will mitigate the negative effect of com-*

petition on the profit of the Home monopolist.

The intuition behind this proposition is fairly simple: both a direct demand increase due to market expansion and an indirect demand increase due to intensified competition constitute sources of additional profit. This possibility was raised by both Katz and Shapiro (1985, p. 431) and Economides (1996b, p. 213) in the closed-market setting. In the context of trade liberalization, however, we can obtain additional insight: both market expansion (from m to 1) and intensified competition (from monopoly to n-firm oligopoly) work as sources of intensified network effects via larger industry size. Although this point is quite intuitive, it has not appeared in the existing closed-economy literature. Let us concentrate on the special case of identical countries (i.e., $m = 1/2$ with one Foreign firm). Comparing points A_i with points T_i in Figure 1, it is clear that the network effect overshadows the standard competitive effect of entry: $\Pi^A < \Pi^T$ holds.

Proposition 2: *If the network effect is sufficiently strong, $n = 2$, and $m = 1/2$, then both countries' profits are higher under trade liberalization than under autarky.*

This point differs from the previous results derived in Anderson et al. (1989, p. 730), which suggest that all firms must lose from trade liberalization if both countries are identical in terms of the number of firms as well as the demand size. Proposition 2 implies that, given significant network effects, both countries' firms have incentives for trade liberalization. In other words, the negative aspect of trade liberalization on firms' profits will be mitigated by the presence of network effects.

Why couldn't the Home monopolist create a larger network without trade liberalization? Note that the model is based on *consumers' expectations of network-wide sales*. Acting as a monopolist that uses only quantity as a strategic variable, the Home monopolist could not commit credibly to producing a larger output in an autarky situation. Thus, trade liberalization

supports the expectation of a high sales volume because consumers know that a more competitive (integrated) industry will have more sales. From the standpoint of the Home monopolist, trade liberalization can be interpreted as a device for the creation of an expanded network.

The analysis until now has been predicated on the assumption of an *integrated* market.[5] We now consider the opposite assumption, *segmented* markets, that arbitrage between these markets is prohibitively costly and the size of each country's network matters. Again, let us concentrate on the case of identical countries. Also, we assume that there are no transport costs. In this case, the Home monopolist's profit in the Home market decreases by opening trade (from $ma^2/(2-b)^2$ to $ma^2/[2(1-b)+1]^2$), which is shown as a movement on downward sloping courves in Figure 1. However, the Home monopolist can obtain profit from the Foreign market ($(1-m)a^2/[2(1-b)+1]^2$). It is clear that the combined profits for the Home monopolist from segmented markets are larger than profits under autarky. Propositions 1 and 2 therfore carry over to the case of the segmented markets with zero transport costs. In the case of positive transport costs (e.g., Brander and Krugman, 1983), however, profit from export becomes smaller and the overall effects of trade liberalization on profits become ambiguous. Thus, there is room for further investigation.

The present note must be regarded as very tentative. Hopefully it provides a useful paradigm with which to consider how network effects work as a driving force for trade liberalization.

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