Endogenous Vertical Structure and Trade Policy in an Import–competing Market with Fulfilled Expectations*

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Abstract

This paper examines the endogenous determination of vertical organization-structure (i.e., vertical integration or separation) when an optimal import tariff is implemented in an import-competing market, where one home firm and one foreign firm engage in price competition under network externalities. The optimal import tariff is higher when the foreign exporting firm is vertically separated than when it is integrated. If firms commit to vertical organization before trade policy, then the foreign firm chooses vertical integration but home firm chooses vertical separation (integration) if network externalities are weak (strong). In addition, the behavior of home firm in a relatively low network externalities is inconsistent with social optimum.

JEL Classification: F12, F13, L13

Key words: Strategic Vertical Separation; Network Externalities, Fulfilled Expectation; Two-Part Tariffs; Optimal Import Tariff

1 Introduction

In an oligopolistic market, it is well-known that firm’s owner can gain strategic advantage by offering their managers incentive contracts that make them behave in owner’s favor. This type of controlling of manager’s behavior is known as “strategic delegation” because it serves
as commitments that influence interactions with rivals and potentially lead to beneficial outcomes for the delegating party. Focusing on the strategic advantages of delegation or vertical separation, many previous studies have been conducted in the following areas. Examples of strategic delegation can be found in papers on delegation of decision making to managers within firms (e.g., see Vickers, 1985; Fershtman and Judd, 1987; Sklivas, 1987), vertical relations between upstream manufacturer and retailer (e.g., see Bonanno and Vickers, 1988; Coughlan and Wernerfelt, 1989; Gal-Or, 1990; Li and Shuai, 2016), and bargaining between parties (e.g., see Jones, 1989; Christiansen, 2013). Most literature on strategic delegation or vertical separation within distribution channels presume domestic market and focus on symmetric vertical market structures resulting from symmetric models. As a result, all of the aforementioned strategic delegation papers obtain symmetric market structures.

However, the above studies lack two perspectives, particularly as described below. First, considering intense competition among firms in the global market frame, confining the analysis on strategic delegation within the domestic market is rather naive. In the real world, numerous firms compete in the international market in a diverse vertical organization structure. Examples of industries where vertical separation is a key feature of the organizational structure include aircraft, automobile, computers, audio/video systems, and so on. Automobiles are developed and manufactured by OEMs and vertical supplier networks, which occupy about 70 percent of the value of the vehicle (Matsushima and Mizuno, 2013). On the other hand, there are many industry and firm-level examples of vertical integration. Oil industry is the case. Multinational oil companies such as ExxonMobile, Royal Dutch Shell and BP have adopted a vertically integrated structure, meaning that they have engaged in from drilling and extracting crude oil, transporting it around the world, refining it into petroleum products, to distributing the fuel to company-owned retail stations, for sales to consumers. As a firm-level evidence, Apple Inc. provides good examples of vertical integration in smartphone industry. Apple retails most of its products via Apple Store, which is a chain of retail stores owned and operated by Apple Inc.

Second, more importantly, most previous studies regarding strategic delegation ignore the effects of the network externalities by assuming non-network goods. In reality, however, many products in IT industry have the special feature of consumption network externalities (also known as “increasing return to scale in consumption”). In other words, a consumer’s utility from consuming the product increases with the number of other users of that goods (i.e., with total sales of the good). For example, a typical consumer’s utility from using a telephone increases with the number of other telephone users. Video game console is also the case. A video game console is more attractive to consumers if more game titles are available for the console type. Because game developers will try to produce game titles for the popular game console, so the more popular game platform is likely to offer consumers higher utilities. Also, reflecting that the diverse vertical organization-structures are common phenomenon in international market, there has been growing literature on exploring the validity of trade policies under vertically related markets. Among them are works by Spencer and Jones (1992), Poterba and Rotemberg (1995), Spencer and Rautbitschek (1995), Ishikawa and Lee (1997), Bernhofen (1997), Ishikawa and Spencer (1999), Skaksen (2005), Mccorriston and Sheldon (2005), Lee (2007), Choi et al. (2016), and Chang and Ryu (2016), which attempt to show the economic incentives of trade policies by constructing a partial equilibrium oligopoly model in the context of a vertically related markets. In most studies, however, the vertical market structure is given exogenously.
for many consumer durable goods, utility of consumer depends on the availability and quality of post-purchase services, which is likely to increase with the total volume of units sold.

In the presence of network externalities, consumers’ willingness to pay for buying a network good (or subscribing to network) depends on their expectations for the market size (i.e., the number of other users who made the same choice). And these expectations will be influenced by observable managerial incentive scheme (or firms’ vertical organization-structure), which can serve as a commitment to consumers. In other words, this implies that firm’s choice of organizational structure (i.e., vertical separation or integration), other than strategic rent shifting effects as in standard Vickers-Fershtman-Judd-Sklivas (VFJS) model, can have an additional effects on firms’ profits via the consumption network externalities.2)

Given the above discussion, focusing on the endogenous determination of firm’s vertical organization-structure, this paper examines the interaction between vertical organizational structure and strategic trade policies in the presence of consumption network externalities.3) It should be emphasized that our paper takes a full-fledged approach to the endogenous determination of firms’ vertical structure in international oligopolistic competition.4) In effect, most of existing literature on strategic trade policies under vertically related markets treats vertical market structure (separation or integration) as exogenously given. As Buehler and Schmutzler (2008) and Jansen (2003) pointed out, firms often strategically choose whether to vertically integrate or separate in an oligopolistic market situation and game-theoretic work has demonstrated that asymmetric vertical market structure may arise endogenously (see e.g., Ordover et al., 1990; Elberfeld, 2002; Jansen, 2003; Dufeu, 2004). The endogeneity of vertical structure might be also true in the context of international competition.

To do this, we construct an import competing oligopoly model, where one domestic firm and one foreign firm compete Bertrand competition in the domestic market, and try to provide answers to following questions on vertical market structure: (1) If vertical structure is endogenously determined by firms’ strategic consideration in the presence of network externalities, then what will be the industry’s vertical structure in equilibrium? (2) How does trade policy of importing country affects firms’ decision? The main results of our paper are as follows. First,

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2) Reflecting a crucial role of network industries in modern life, a substantial body of literature have examined network externalities. However, to the best of our knowledge, little attention has been paid to the issues regarding the interaction between strategic managerial delegation (or the choice of firms’ organizational structure) and network externalities in these studies. Recently, Hoering (2012), Bhattacharjee and Pal (2013), and Pal (2015) have examined the implications of network externalities on strategic managerial delegation by using the framework of VFJS model. Nevertheless, since these studies are limited to the domestic market, there is no consideration regarding the role of trade policies in interaction with strategic delegation.

3) This paper is closely related to Lee et al. (2020) in the sense that both deal with the endogenous determination of firms’ vertical organization structure when firms compete in international oligopolistic market. However, since aforementioned study assumes non-network goods, i.e., goods are such that there are no consumption/network externalities, it does not deal with the effects of both network externalities and the consumers’ expectations regarding market size in determining firms’ vertical organization structure. This study has the meaning of generalizing Lee et al. (2020) by explicitly taking into consideration network externalities in the mode.

4) Some of the theoretical studies examine the implications of separation of ownership and management for trade policies (Das, 1997; Wang et al., 2009). While these studies investigate whether such strategic delegation or vertical separation may reduce the need for or scale of strategic trade policies, they do not explicitly address the endogenous determination of firms’ vertical organization-structure.
we show that the optimal import tariff imposed by the domestic government is higher when the foreign exporting firm is vertically separated than when it is vertically integrated, which in turn reduces the incentives for the vertical separation of the foreign exporting firm. Second, in relation to the first, it is the dominant strategy to choose vertical integration for the foreign manufacturer as its organizational structure. On the other hand, the vertical structure of the domestic firm depends on the relative magnitude between rent shifting effects and network effects. If the strength of network effects is higher than the threshold level (i.e., \( n > n^* \)), then (vertical integration, vertical integration) emerges as an organizational structure for home and foreign firm, respectively, whereas if that is lower than the threshold level (i.e., \( n < n^* \)), then (vertical separation, vertical integration) emerges. Third, social welfare under (vertical integration, vertical integration) regime is greater than that under (vertical separation, vertical integration) regime for any strength of network externalities, implying that if \( n > n^* \), firm’s behavior based on self-interests to determine its organizational structure is consistent with social optimum but if \( n < n^* \), these behavior are not consistent with the social optimum.

Our findings provide sharp contrast with Ziss (1997), which examines the endogenous determination of vertical structure using export–rivalry model without considering network externalities. Unlike Ziss (1997), in which vertical separation is the dominant strategy under Bertrand competition for both domestic and foreign firms, we have demonstrated that both firms choose vertical integration as their organizational structure if network externalities are sufficiently strong whereas the home firm chooses vertical separation but the foreign firm vertical integration if the network externalities are weak. In addition, as most previous studies on strategic delegation model, Ziss (1977) also focuses on symmetric vertical market structure, i.e., vertical separation by both firms, resulting from export–rivalry model. On the other hand, we have demonstrated that asymmetric vertical market structure, home firm vertical separation while foreign firm vertical integration, arises endogenously if the network externalities are weak, which provides theoretical background for the asymmetric vertical market structure in the real economy.

This paper is organized as follows. Section 2 outlines the simple import–competing model of differentiated products used in the analysis. Section 3 derives the outcomes under each four possible organizational structure, which is determined in the previous stage of the game; these are vertical integration by both firms, domestic (resp. foreign) firm vertical integration and foreign (resp. domestic) firm vertical separation, and vertical separation by both firms. This Section also contains a discussion of the strategic nature of vertical separation. Chapter 4 deals with the endogenous determination of the firms’ vertical organization–structure on the part of the upstream manufacturer. Section 5 provides concluding remarks.

2 Model

Consider an import market consisting of a home firm (firm \( h \)) and a foreign firm (firm \( f \)). The two firms sell network products and compete in the home market (i.e., \( h \) market). Following Hoering (2012), the utility function of the representative consumer is as follows:

\[ p^i = a - x^i - bx^i + n(y^i + by^i); \quad i, j = h, f; i \neq j. \]
\[ U = a(x^i + x^j) - \frac{(x^i)^2 + (x^j)^2 + 2bx^ix^j}{2} + n \left[ (y^i + by^j)x^i + (y^j + by^j)x^j - \frac{(y^i)^2 + (y^j)^2 + 2by^iy^j}{2} \right] + m, \] (1)

where \( m \) denotes the consumption of all other goods, measured in terms of money; \( x^i \) denotes the quantity of final product \( i \); \( y^i \) denotes consumers’ expectations about final product \( i \)'s quantity; \( b \in (0,1) \) represents the degree of product differentiation; and \( n \in (0,1) \) measures the strength of the network externalities. Note that the marginal utility of product \( i \) increases in \( y^i \) and \( y^j \): \( \partial^2 U/\partial x^i \partial y^i = bn > 0 \) and \( \partial^2 U/\partial x^j \partial y^j = n > 0 \), respectively.\(^6\) This implies that there are positive consumption externalities. It is evident that for given consumption bundle \( (x^i, x^j) \), utilities reach their highest level, if consumers’ expectations are correct (i.e., \( y^i = x^i \) and \( y^j = x^j \)). The direct demand function for product \( i \) can be derived as follows (see also Hoer, 2012).

\[ x^i = \frac{a(1-b) - p^i + by^i + ny^i(1-b^2)}{1-b^2}; i, j = h, f, i \neq j, \] (2)

where \( p^i \) and \( p^j \) are the final product price respectively. Assume that one unit of the final product exactly needs one unit of the intermediate goods. The government of the home country imposes an import tariff \( t \) on the importing goods by the foreign firm.

Unlike Hoernig (2012), we employ fulfilled expectations equilibrium in the present paper. The timing of the game is as follows. At stage zero, each firm decides the organizational structure (either vertical integration or separation). At stage 1, consumers form the fulfilled expectations equilibrium about future sizes of network with which each firm is associated. At stage 2, the import government imposes the import tariff on per unit of imports. At stage 3, the upstream firm sets the input price and fixed fee, if each firm decides the vertical separation at stage 1.\(^7\) Finally, at stage 4, each firm (or downstream firm) sets the price. The profits of foreign firm \( f \) and home firm \( h \) are, respectively, given as follows:

\(<Case of Vertical Separation>\)

\[ \Pi^f = \Pi^{\Pi}(p^f, w^f, V^f; y^f, n) = (p^f - w^f)x^f - V^f, \] (3.1)

\[ \Pi^h = \Pi^{\Pi}(p^h, w^h, V^h; y^h, n) = (p^h - w^h)x^h - V^h, \] (3.2)

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\(6\) Note that since two products are imperfect substitutes the effect of \( y^j \) on marginal utility of product \( i \) is smaller than that of \( y^i \).

\(7\) If both firm decide the vertical integration at stage 1, this stage will be omitted. Therefore, the case will be examined in three stage game.
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<Case of Vertical Integration>

\[
\Pi^h \left[ p; y^h, n \right] = \left( p^h - c \right) x^h, \quad \Pi^f \left[ p; t; y^f, n \right] = \left( p^f - c - t \right) x^f. \tag{3.3}
\]

In above equations, \( w^i \) is the per-unit wholesale price charged by upstream manufacturer \( i \), \( t \) is the specific import tariff, and \( V^i \) is the fixed fee between the manufacturer and its retailer. The government of the home country sets the import tariff so as to maximize social welfare (SW), which is given as follows:

\[
SW = CS + PS + t x^f, \tag{4}
\]

where \( CS \left( U - p^h x^h - p^f x^f \right) \) is the consumer surplus, \( PS \left( \equiv \Pi^h \right) \) is the producer surplus and \( t \times x^f \) is the tariff revenue of importing country.

3 Analysis

There are possibly four different vertical structures: both upstream firm choosing vertical integration (VI), both choosing vertical separation (VS), and two asymmetric vertical structures which consist two different cases; one is that only home firm chooses vertical separation (HS), and the other is only foreign firm chooses vertical separation (FS).

Case 1. Vertical Integration (regime VI):

At stage 4, each firm choose \( p^i \) to maximize its profits for given the tariff level and the rival’s price \( p^j \). Each firm’s maximization problem is as follows:

\[
\max_{p^i} \Pi^h \left[ p; y^h, n \right] = \left( p^h - c \right) x^h, \quad \max_{p^i} \Pi^f \left[ p; t; y^f, n \right] = \left( p^f - c - t \right) x^f. \tag{5}
\]

By solving the first order conditions, we obtain the response function of each firm as follows:

\[
R^h \left[ p^f; y^h, n \right] = \frac{a(1-b)+c+bp^f+n(1-b^2)}{2} y^h, \tag{6.1}
\]

\[
R^f \left[ p^h; t; y^f, n \right] = \frac{a(1-b)+(c+t)+bp^h+n(1-b^2)}{2} y^f. \tag{6.2}
\]

Solving the two response functions simultaneously, we obtain the equilibrium prices at this stage of the game as follows:

\[
p^h_{VI} \left[ t; y, n \right] = \frac{a(2-b-b^2)+2c+b(c+t)+n(1-b^2)(2y^h+by^f)}{4-b^2}, \tag{7.1}
\]

\[
p^f_{VI} \left[ t; n, y \right] = \frac{a(2-b-b^2)+bc+2(c+t)+n(1-b^2)(2y^f+by^h)}{4-b^2}, \tag{7.2}
\]

where subscript ‘VI’ denotes both upstream firms’ choosing vertical integration. We obtain the home country’s social welfare function in terms of tariff level and network parameters. That is,
where \( \mathbf{p}_V = \left( p^h_V, p^f_V \right) \) stands for the price vector. Therefore, in the second stage of the game, the problem of the domestic government is \( \max_i SW_{VT} [t; y, n] \). More formally, by applying the envelope theorem, we obtain

\[
\frac{\partial SW_{VT} [t; n, y]}{\partial t} = -x^h_{VT} \frac{\partial p^h_V}{\partial t} + \left( p^h_V - c \right) \frac{\partial x^h}{\partial p^h} \frac{\partial p^h_V}{\partial t} + \left( 1 - \frac{\partial p^f_V}{\partial t} \right) x^f_{VT} + t - \frac{\partial x^f_{VT}}{\partial t}. \tag{9}
\]

The first term on the right-hand side (RHS) of the equation represents the consumer surplus loss caused by a price increase for good \( h \); the second term, the rent-shifting effects from the foreign to the home country; the third term, the gain from terms of trade improvement; and the last term, the tax–wedge effect. We find that \( \frac{\partial SW_{VT} [t; n, y]}{\partial t} \big|_{t=0} > 0 \), implying that a small tariff benefits the importing country. Solving the first order condition of welfare maximization yields the optimal tariff rate in the VI regime as follows:

\[
t^*_V [n] = \frac{(1 - b^2) \left[ a - c + n (by^h + y^f) \right]}{3 - 2b^2} \tag{10}
\]

In Eq. (10), we find that \( \frac{\partial t^*_V}{\partial y^i} > 0 \) for \( i = h, f \), implying that the greater the consumers’ expectation regarding market size the higher the equilibrium import tariff. At stage 1, we restrict expectations to be fulfilled at the realized equilibrium, that is, \( y^i = x^i \) and \( y^j = x^j \), hold, respectively. As a result, the equilibrium tariff rate in this regime is\(^8\)\):

\[
t^*_V [n] = \frac{2 - b^2}{\Psi_{VI}} \left( 1 - b^2 \right) \left( 2 + b - n \right) (a - c), \tag{11}
\]

where \( \Psi_{VI} = 2b^4 + 2(3 - n)(2 - n) - b^2 \left\{ 11 - (6 - n)n \right\} > 0 \). Substituting \( t^*_V [n] \) into market variables, we can obtain equilibrium market variables under VI regime as follows (the constants \( A_0 \) and \( A_1 \) are given in Appendix 1):

\[
x^h_{VT} [n] = \frac{(2 - b^2) \left[ 3 + 2b - n \right] (a - c)}{(1 + b) \Psi_{VI}}, \quad x^f_{VT} [n] = \frac{4 + b - 3b^2 - 3 - 2b^2 \left[ a - c \right]}{(1 + b) \Psi_{VI}}, \tag{12.1}
\]

\[
\Pi^h_{VT} [n] = \left( 1 - b^2 \right) \left( x^h_{VT} [n] \right)^2, \quad \Pi^f_{VT} [n] = \left( 1 - b^2 \right) \left( x^f_{VT} [n] \right)^2, \tag{12.2}
\]

\[
CS_{VT} [n] = \frac{A_0 \left[ 1 - n \right] (a - c)^2}{2(1 + b) \left[ \Psi_{VI} \right]^2}, \quad SW_{VT}^* [n] = \frac{A_1 \left[ a - c \right]^2}{2(1 + b) \left[ \Psi_{VI} \right]^2}. \tag{12.3}
\]

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8) A superscript ‘*’ is used to represent the equilibrium values in the first stage of the game when optimal import tariff is implemented in the second stage.
Case 2. Home Firm, Integration; Foreign Firm, Separation (regime FS):

We consider the case where home firm chooses vertical integration while the foreign firm chooses vertical separation. The maximization problem of each firm in the domestic downstream market is

\[ \max_{p^h} \Pi^h[p, y^h, n] \]

for the home firm and

\[ \max_{p^f} \pi^f[p; w^f, V^f, t; y^f, n] \]

for the foreign independent retailer. The response function of the home firm is given by

\[ R^h[p^h; y^h, n] \]

in Eq. (6.1) while that of foreign retailer is obtained by replacing \( c + t \) in Eq. (6.2) with \( w^f + t \). Solving the system of two response functions gives the equilibrium prices at this stage of the game as follows:

\[ p^h[w^f, t; y, n] = \frac{a(2 - b - b^2) + 2c + b(w^f + t) + n(1 - b^2)(2y^h + by^f)}{4 - b^2}, \]

(13.1)

\[ p^f[w^f, t; y, n] = \frac{d(2 - b - b^2) + 2c + 2(w^f + t) + n(1 - b^2)(2y^f + by^f)}{4 - b^2}. \]

(13.2)

Note that \( c, c + t \) in Eqs. (7.1) and (7.2) is replaced by \( c, w^f + t \) in Eqs. (13.1) and (13.2). In addition, \( \frac{\partial p^h}{\partial w^f} = \frac{b}{4 - b^2} > 0 \), implying that if independent upstream manufacturer \( f \) increases the wholesale price at which its exclusive retailer buys, then the retail price of rival firm, \( p^h \), also increases. We call this the cross effect of wholesale price to the rival’s retail price.

In stage 3, independent upstream manufacturer \( f \) determines its contract \( (w^f, V^f) \) such that

\[ \max_{w} \Pi^f[w^f, t; y, n] = (w^f - c)x^f[p[w^f, t; y, n], y^f, n] + V^f, \]

s.t. \( V^f = (p^f[w^f, t; y, n] - w^f - t)x^f[p[w^f, t; y, n], y^f, n] \),

(14)

where \( p^h \) and \( p^f \) are given by Eqs. (13.1) and (13.2), respectively. By applying envelope theorem, we obtain

\[ \frac{\partial \Pi^f[w^f, t; y, n]}{\partial w^f} = (w^f - c) \frac{\partial x^f}{\partial p^f} \frac{\partial p^f}{\partial w^f} + \left( p^f - c - t \right) \frac{\partial x^f}{\partial p^h} \frac{\partial p^h}{\partial w^f}, \]

(15.1)

Decrease in Derived Demand Rent Shift Effect

\[ \frac{\partial^2 \Pi^f[w^f, t; y, n]}{\partial t \partial w^f} = \left( \frac{\partial p^f}{\partial t} - 1 \right) \frac{\partial x^f}{\partial p^h} \frac{\partial p^h}{\partial w^f} < 0. \]

(15.2)

The first term on the RHS of Eq. (15.1) represents the profit loss of independent upstream manufacturer \( f \), accruing from the decrease in derived demand, while the second term represents the strategic rent shifting effects from the rival firm by charging a higher wholesale price. Given \( t \), an increase in wholesale price by the independent upstream manufacturer generates two conflicting effects on its own profits, meaning the net effects could be either positive...
or negative. However, evaluating Eq. (15.1) at $w^f = c$ yields
\[ \frac{\partial \pi^f}{\partial w^f} \bigg|_{w^f = c} = \left( p^f - c - t \right) \frac{\partial x^f}{\partial p^h} \frac{\partial p^h}{\partial w^f} > 0, \]
implies firm $f$’s best response to the rival’s vertical integration is setting a positive $w^f$ above its cost per unit, that is, choosing vertical separation. Strategic vertical separation is commonly observed in the literature on the strategic separation model with strategic complements (Bonanno and Vickers, 1988). That is, an increase in $w^f$ from its marginal cost (i.e., choosing vertical separation) leads to a price increase by the rival firm in the retail market (i.e., the cross effects of wholesale price to the rival’s retail price), which in turn shifts profits from the rival firm to firm $f$. Additionally, in Eq. (15.2), we have
\[ \frac{\partial^2 \Pi^f[w^f, t; n, y]}{\partial t \partial w^f} = \left( \frac{\partial p_f}{\partial t} - 1 \right) \frac{\partial x^f}{\partial p^h} \frac{\partial p^h}{\partial w^f} < 0, \]
implies that an increase in the import tariff by the home country reduces the magnitude of the rent-shifting effects of the vertical separation of firm $f$. The intuition for this is straightforward. Because the import tariff of the domestic government deteriorates the price-cost margins of the foreign independent retailer, it also tends to decrease the incentive for the vertical separation of the firm in the exporting country.

By solving $\frac{\partial \Pi^f[w^f, t; n, y]}{\partial w^f} = 0$, we can obtain the equilibrium wholesale price and fixed fees under the FS regime as follows:

\[
\begin{align*}
  w^f_{FS}[t; y, n] &= c + \frac{b^2}{4} \left[ \frac{(2 - b - b^2)(a - c) + n(1 - b^2)(2y^f + by^h)}{2 - b^2} \right], \\
  v^f_{FS}[t; y, n] &= \frac{(2 - b - b^2)(a - c) - (2 - b^2)t + n(1 - b^2)(2y^f + by^h))^2}{16(1 - b^2)}.
\end{align*}
\]

Using the equilibrium wholesale price and fixed fee given in Eq. (16), we can obtain the equilibrium values of market variables at stage 3. In the second stage, by substituting these equilibrium prices and quantities into Eq. (4), the problem of the domestic government can be written as $\max_{t} SW_{FS}[t; y, n] = CS_{FS}[t; y, n] + \Pi^h_{FS}[t; y, n] + \Pi^f_{FS}[t; y, n] + t x^f_{FS}[t; y, n]$ under the FS regime. By differentiating $SW_{FS}[t; y, n]$ with respect to $t$, we obtain
\[
\frac{\partial SW_{FS}[t; n, y]}{\partial t} = -x^f_{FS} \frac{\partial p^h_{FS}}{\partial t} + \left( p^h_{FS} - c \right) \frac{\partial x^h}{\partial p^f} \frac{\partial p^f_{FS}}{\partial t} + \left( 1 - \frac{\partial p^f_{FS}}{\partial t} \right) x^f_{FS} + t \frac{\partial x^f_{FS}}{\partial t}.
\]

As was in Eq. (9), the first, second, third, and the last term represent the loss in consumer surplus, gain from rent shift, terms of trade gain, and negative tax–wedge effects, respectively. In addition, we have $\frac{\partial SW_{FS}[t; n, y]}{\partial t} \bigg|_{t=0} > 0$, implying a small tariff benefits the importing country under the FS regime. In stage 2, the government of the home country chooses the tariff rate to maximize social welfare. Solving this second-stage of the game, we
get the optimal tariff rate under the FS regime as
\[
t_{FS}[y,n] = \frac{(8-10b^2-b^2+3b^4)(a-c)+(1-b^2)n[(8-3b^2)by^f+2(4-b^2)y^f]}{24-26b^2+7b^4}. \tag{18}
\]

At stage 1, using \(y^f = x^f\) and \(y' = x'\) conditions and optimal tariff given in Eq. (18), we can obtain the equilibrium import tariff with fulfilled expectations as follows:
\[
t_{FS}^*[n] = \frac{(1-b)[8+8b-2b^2-3b^3-(2+b)(2-b^2)n](a-c)}{(2-b^2)\Psi_{FS}}, \tag{19}
\]
where \(\Psi_{FS} = 12-7b^2-2n(5-2b^2)+n^2(2-b^2) > 0\). In addition, substituting the expression for the optimal tariff rate, \(t_{FS}^*[n]\), into the expressions for prices, quantities, profits, consumers’ surplus, and social welfare, we obtain the equilibrium values for these variables as follows (the constants \(A_2\) and \(A_3\) are given in Appendix 1):
\[
x_{FS}^*[n] = \frac{[2(3-n)+b(4-b(1-n))](a-c)}{(1+b)\Psi_{FS}}, \quad x_{FS}^*[n] = \frac{[4+b-3b^2-b^3-n(2-b^2)](a-c)}{(1+b)\Psi_{FS}}, \tag{20.1}
\]
\[
\Pi_{FS}^*[n] = \frac{2(1-b^2)}{2-b^2} \left( x_{FS}^*[n] \right)^2, \quad \Pi_{FS}^*[n] = \frac{2(1-b^2)}{2-b^2} \left( x_{FS}^*[n] \right)^2, \tag{20.2}
\]
\[
CS_{FS}^*[n] = \frac{[A_2](1-n)(a-c)^2}{2(1+b)\Psi_{FS}^3}, \quad SW_{FS}^*[n] = \frac{[A_3](a-c)^2}{2(1+b)\Psi_{FS}^3}. \tag{20.3}
\]

**Case 3. Home Firm, Separation; Foreign Firm, Integration (regime HS):**

Regime HS, home firm’s choosing vertical separation while the foreign firm vertical integration, is just the opposite of regime FS. Equilibrium prices in the last stage of the game under this regime are obtained by replacing \((c,c+t)\) in Eqs. (7.1) and (7.2) with \((w^h,c+t)\). That is,
\[
p^h \left[ w^h,t;y,n \right] = \frac{a(2-b-b^2)+2w^h+b(c+t)+n(1-b^2)(2y^h+by^f)}{4-b^2}, \tag{21.1}
\]
\[
p^f \left[ w^h,t;y,n \right] = \frac{a(2-b-b^2)+2(c+t)+bw^h+n(1-b^2)(2y^f+by^h)}{4-b^2}. \tag{21.2}
\]

In above equations, the cross effect of wholesale price to the rival’s retail price holds, i.e.,
\[
\frac{\partial p_i^f}{\partial w^h} = \frac{b}{4-b^2} > 0.
\]

In stage 3 of the game, independent upstream manufacturer \(h\) determines contract \((w^h,V^h)\) via \(\max_{w^h} \Pi^h \left[ w^h,t;y,n \right] = \left( p^h \left[ w^h,t;y,n \right] - c \right) x^h \left[ p^h \left( w^h,t;y,n \right), y^h, n \right] \), where \(p^i\) for \(i = h,f\) are given by Eqs. (21.1) and (21.2). By differentiating \(\Pi^h \left[ w^h,t;y,n \right]\) with respect to \(w^h\), we obtain
\[
\frac{\partial \Pi^h}{\partial w^h} \left[ w^h, t; y, n \right] = \left( w^h - c \right) \frac{\partial x^h}{\partial p^h} \frac{\partial p^h}{\partial w^h} + \left( p^h - c \right) \frac{\partial x^h}{\partial p^f} \frac{\partial p^f}{\partial w^h} \quad \text{(22.1)}
\]

Decrease in Derived Demand Rent Shift Effect

\[
\frac{\partial^2 \Pi^h}{\partial t \partial w^h} \left[ w^h, t; y, n \right] = \frac{\partial p^h}{\partial t} \frac{\partial x^h}{\partial p^f} \frac{\partial p^f}{\partial w^h} > 0,
\]

where the first term, the loss of profits due to the decrease in derived demand, is negative while the second term, rent-shifting effects from the rival firm, is positive. In Eq. (22.1), two points are noteworthy. First, upstream manufacturer \( h \)'s best response to the rival’s vertical integration is vertical separation since \( \frac{\partial \Pi^h}{\partial w^h} \bigg|_{w^h=c} = \left( p^h - c \right) \frac{\partial x^h}{\partial p^f} \frac{\partial p^f}{\partial w^h} > 0 \). Second, an increase in \( t \) raises the incentives of firm \( h \)'s vertical separation because \( -\frac{\partial^2 \Pi^h}{\partial t \partial w^h} = \frac{\partial p^h}{\partial t} \frac{\partial x^h}{\partial p^f} \frac{\partial p^f}{\partial w^h} > 0 \) holds.

Solving \( \frac{\partial \Pi^h}{\partial w^h} = 0 \) yields the equilibrium wholesale price and fixed fees under the HS regime as follows:

\[
w^h_{HS} [t; y, n] = c + b^2 \frac{4}{2 - b^2} \left[ \left( 2 - b - b^2 \right) \left( a - c \right) + bt + \left( 1 - b^2 \right) \left( 2y^h + by^f \right) \right],
\]

\[
\Pi^h_{HS} [t; y, n] = \left[ \left( 2 - b - b^2 \right) \left( a - c \right) + bt + \left( 1 - b^2 \right) \left( 2y^h + by^f \right) \right]^2.
\]

Using the equilibrium wholesale price and fixed fee given in Eq. (23), we can obtain the social welfare under HS regime as a function of \( t, y, \) and \( n \), that is, \( SW_{HS} [t; y, n] = CS_{HS} [t; y, n] + \Pi^h_{HS} [t; y, n] + tx^f_{HS} [t; y, n] \). By differentiating \( SW_{HS} [t; y, n] \) in terms of \( t \), we have

\[
\frac{\partial SW_{HS}}{\partial t} = -x^h_{HS} \frac{\partial x^h}{\partial t} + \left( w^h_{HS} - c \right) \frac{\partial x^h}{\partial p^h} \frac{\partial p^h}{\partial t} + \left( p^h_{HS} - c \right) \frac{\partial x^h}{\partial p^f} \frac{\partial p^f}{\partial t} + \left( 1 - \frac{\partial p^f}{\partial t} \right) x^f_{HS} + t \frac{\partial x^f_{HS}}{\partial t}.
\]

(24)

Compared to Eq. (17), the new term \( \left( w^h_{HS} - c \right) \frac{\partial x^h}{\partial p^h} \frac{\partial p^h}{\partial t} \) \((< 0)\) is added in square brackets on the RHS of Eq. (24). This term represents the profit loss of the independent domestic upstream firm caused by the decline in the retailer’s demand for the products produced by the domestic upstream firm. Solving \( \frac{\partial SW_{HS}}{\partial t} = 0 \), we obtain the optimal import tariff level under
Endogenous Vertical Structure and Trade Policy in an Import-competing Market with Fulfilled Expectations

HS regime as follows:

$$t_{HS}[y, n] = \frac{(16 - 28b^2 + 2b^3 + 11b^4 - b^5)(a - c) + (1 - b^2)n[2(8 - 5b^2)by + (16 - 12b^2 + b^4)y']}{48 - 68b^2 + 23b^4}. \tag{25}$$

Similarly, at stage 1, using $$y' = x'$$ and $$y' = x'$$ conditions and optimal tariff given in Eq. (25), we can obtain the equilibrium import tariff with fulfilled expectations under the HS regime as follows:

$$t_{HS}^*[n] = \frac{(1 - b)[8(2 - n) + 4b(4 - n) - b^2(12 + 10b - b^2 - n(10 + 2b - 3b^2))]}{\Psi_{HS}}(a - c), \tag{26}$$

where $$\Psi_{HS} = 48 - 68b^2 + 23b^4 - n(40 - 50b^2 + 14b^4) + n^2(8 - 10b^2 + 3b^4) > 0$$. Substituting $$t_{HS}^*[n]$$ into the expressions for prices, quantities, profits, consumers’ surplus, and social welfare, we obtain the equilibrium values for these variables as follows (the constants $$A_4$$ and $$A_5$$ are given in Appendix 1):

$$x_{HS}^*[n] = \frac{(2 - b^2)(4 - 3b^2)(3 + 2b - n)(a - c)}{(1 + b)\Psi_{HS}}, \tag{27.1}$$

$$x_{HS}^{f*}[n] = \frac{16 + 4b - 20b^2 - 4b^3 + 5b^4 - n(8 - 10b^2 + 3b^4)}{(1 + b)\Psi_{HS}}(a - c), \tag{27.2}$$

$$\Pi_{HS}^{h*}[n] = \frac{2(1 - b^2)}{(2 - b^2)}(x_{HS}^{h*}[n])^2, \Pi_{HS}^{f*}[n] = (1 - b^2)(x_{HS}^{f*}[n])^2, \tag{27.3}$$

Case 4. Vertical Separation (regime VS):

The equilibrium prices in the last stage of the game under the VS regime are obtained by replacing $$(c, c + t)$$ with $$(w^h, w^f + t)$$ in Eqs. (7.1) and (7.2). That is,

$$p_{h}[w, t; y, n] = \frac{a(2b - b^2) + 2w^h + b(2y^h + by^f)}{4 - b^2}, \tag{28.1}$$

$$p_{f}[w, t; y, n] = \frac{a(2b - b^2) + 2(w^f + t) + bw^h + n(1 - b^2)(2y^f + by^h)}{4 - b^2}, \tag{28.2}$$

where $$w = (w^h, w^f)$$ represents the vector of wholesale prices. In equations, we can find that $$\frac{\partial p_{j}}{\partial w_{i}} = \frac{b}{4 - b^2} > 0 \quad (i, j = h, f; i \neq j)$$ holds. In stage 3, each upstream manufacturer, vertically separated, offers contract $$(w^i, V^i)$$ to its independent retailer to maximize profits. Since
fixed fees are set so that they fully extract the retailer’s anticipated profits, the maximization problem of the upstream manufacturer is reduced to \( \max_{w^i} \Pi^i[w, t; y, n] = \left( p^i - c - \delta t \right) x^i \)
\[ \left[ p[w, t; y, n], y^i, n \right], \] where \( p^i \) for \( i = h, f \) are given by Eqs. (28.1) and (28.2) and \( \delta = 1 \) if \( i = f \) and 0 otherwise. By applying the envelope theorem, we obtain:
\[ \frac{\partial \Pi^i[w, t; y, n]}{\partial w^i} = \left( p^i - c \right) \frac{\partial x^i}{\partial p^i} \frac{\partial p^i}{\partial w^i} + \left( p^i - c - \delta t \right) \frac{\partial x^i}{\partial p^i} \frac{\partial p^i}{\partial w^i}, \] (29.1)
\[ \frac{\partial^2 \Pi^h}{\partial t \partial w^h}\big|_{y_S} > 0, \quad \frac{\partial^2 \Pi^f}{\partial t \partial w^f}\big|_{y_S} < 0. \] (29.2)

The sign of the marginal effects of the wholesale price on its profits is ambiguous. However, if we evaluate Eq. (29.1) at \( w^i = c \), we have \( \frac{\partial \Pi^i}{\partial w^i}\big|_{w^i = c} = \left( p^i - c - \delta t \right) \frac{\partial x^i}{\partial p^i} \frac{\partial p^i}{\partial w^i} > 0 \), implying that, given the import tariff rate, upstream manufacturer \( i \)’s best response to the rival’s vertical separation decision is setting wholesale price above its marginal cost (i.e., \( w^i > c \)), namely choosing vertical separation. Moreover, \( \frac{\partial^2 \Pi^h}{\partial t \partial w^h}\big|_{y_S} > 0 \) and \( \frac{\partial^2 \Pi^f}{\partial t \partial w^f}\big|_{y_S} < 0 \) in Eq. (29.2) imply that an increase in import tariff by the home country increases the motivations for vertical separation of firm \( h \) in the importing country but reduces the motivations for vertical separation of firm \( f \) in the exporting country, given that the respective rival firm is vertical separated.

Solving \( \frac{\partial \Pi^h}{\partial w^h} = 0 \) and \( \frac{\partial \Pi^f}{\partial w^f} = 0 \) simultaneously, we obtain the equilibrium wholesale prices under the VS regime as follows:
\[ w^h_{VS}[t; y, n] = c + \frac{b^2 \left( 4 - 2b - 3b^2 + b^3 \right) \left( a - c \right) + \left( 2 - b^2 \right) bt + n \left( 1 - b^2 \right) \left( 4 - b^2 \right) y^h + 2by^f}{\left( 4 + 2b - b^2 \right) \left( 4 - 2b - b^2 \right)} , \] (30.1)
\[ w^f_{VS}[t; y, n] = c + \frac{b^2 \left( 4 - 2b - 3b^2 + b^3 \right) \left( a - c \right) - \left( 4 - 3b^2 \right) t + n \left( 1 - b^2 \right) \left( 4 - b^2 \right) y^f + 2by^h}{\left( 4 + 2b - b^2 \right) \left( 4 - 2b - b^2 \right)} . \] (30.2)

In above equations, it holds that \( \frac{\partial w^h_{VS}}{\partial t} > 0 \) and \( \frac{\partial w^f_{VS}}{\partial t} < 0 \), implying an increase in \( t \) reduces the incentive for vertical separation of firm \( f \) but increases the incentive for vertical separation of firm \( h \). Using these retail prices in Eqs. (30.1) and (30.2), we can obtain market variables as well as social welfare under the VS regime in terms of \( t, y \) and \( n \), that is, \( SW_{VS}[t; y, n] = CS_{VS}[t; y, n] + \Pi^h_{VS}[t; y, n] + tx^f_{VS}[t; y, n] \). By differentiating \( SW_{VS}[t; y, n] \) in terms of \( t \), we have
\[
\frac{\partial SW_{VS}}{\partial t} = -x_{VS}^{h} \frac{\partial p_{VS}^{h}}{\partial t} + \left\{ w_{VS}^{h} - c \right\} \frac{\partial x_{VS}^{h}}{\partial w_{VS}^{f}} \left( \frac{\partial p_{VS}^{h}}{\partial w_{VS}^{f}} + \frac{\partial p_{VS}^{h}}{\partial t} \right) + \left( p_{VS}^{h} - c \right) \frac{\partial x_{VS}^{h}}{\partial p_{VS}^{f}} \left( \frac{\partial w_{VS}^{f}}{\partial w_{VS}^{f}} + \frac{\partial p_{VS}^{f}}{\partial t} \right) + \left( 1 - \frac{\partial p_{VS}^{f}}{\partial t} \right) x_{VS}^{f} + \frac{\partial x_{VS}^{f}}{\partial t}. \tag{31}
\]

Each term on the RHS of Eq. (31) represents consumer surplus loss due to the price increase in good \( h \), the net gain of producer surplus\(^9\) consisting of the profit loss of the upstream manufacturer caused by the decline in derived demand and the profit gain due to the rent shifting from the rival firm, gains from terms of trade improvement, and negative effects of the tax–wedge on government revenue, respectively. Additionally, we have \( \frac{\partial SW_{VS}}{\partial t} |_{t=0} > 0 \) and \( \frac{\partial^{2} SW_{VS}}{\partial t^{2}} < 0 \), implying that a small tariff benefits the importing country. Solving the first-order condition in the second stage of the game, we obtain the optimal import tariff under the VS regime as follows:

\[
t_{VS}[y, n] = \frac{2\left(1-b^{2}\right)\left(2+b-a\right)+n\left(by^{h}+y^{f}\right)}{6-5b^{2}}. \tag{32}
\]

At stage 1, using \( y^{i} = x^{i} \) and \( y^{f} = x^{f} \) conditions and optimal tariff given in Eq. (32), we can obtain the equilibrium import tariff with fulfilled expectations under the VS regime as follows:

\[
t_{VS}^{*}[n] = \frac{2\left(1-b^{2}\right)\left(4-b(2+b)\right)\left(4+b(2+b)\right)-n\left(2-b^{2}\right)}{(1+b)\Psi_{VS}}. \tag{33}
\]

where \( \Psi_{VS} = 96 - 152b^{2} + 66b^{4} - 5b^{6} - 2n\left(40 - 62b^{2} + 29b^{4} - 4b^{6}\right) + n^{2}\left(16 - 28b^{2} + 16b^{4} - 3b^{6}\right) > 0 \). In addition, by substituting \( t_{VS}^{*}[n] \) into the expressions for prices, quantities, profits, consumers’ surplus, and social welfare, we obtain the equilibrium values for these variables as follows (the constants \( A_{6} \) and \( A_{7} \) are given in Appendix 1):

\[
x_{VS}^{h}[n] = \frac{8-10b^{2}+3b^{4}}{1+b}\Psi_{VS} \tag{34.1},
\]

\[
x_{VS}^{f}[n] = \frac{2-2b^{2}}{1+b}\Psi_{VS} \tag{34.2},
\]

\[
\Pi_{VS}^{h}[n] = \frac{2(1-b^{2})}{(1+b)}\left(x_{VS}^{h}[n]\right)^{2}, \quad \Pi_{VS}^{f}[n] = \frac{2(1-b^{2})}{(1+b)}\left(x_{VS}^{f}[n]\right)^{2}, \tag{34.3}
\]

\[
CS_{VS}^{*}[n] = \frac{A_{6}}{(1+b)\Psi_{VS}} \tag{34.4},
\]

\[
SW_{VS}^{*}[n] = \frac{A_{7}}{(1+b)\Psi_{VS}^{2}}. \tag{34.4}
\]

---

\(^9\) The net effects of import tariff on producer’s surplus are positive (see Appendix 2).
4 Endogenous Determination of Vertical Structure

In the previous sections, we analyzed the market equilibriums under each organizational structure. Before explaining the choice of the endogenous organizational structure at stage zero, let us compare the equilibrium outputs and tariff between vertical separation and vertical integration. Comparing each outcome, we obtain the following results.

**Lemma 1:** Regardless of the size of $n$ and $b$, the following inequalities hold: (1) $x_{VI}^{h*} > x_{VS}^{h*}$ and $x_{FS}^{h*} > x_{FS}^{h*}$, (2) $x_{VI}^{f*} > x_{FS}^{f*}$ and $x_{HS}^{f*} > x_{FS}^{f*}$, and (3) $t_{FS}^{*} > t_{FI}^{*}$ and $t_{FS}^{*} > t_{FH}^{*}$.

**Proof:** Appendix 3.

Lemma 1(3) implies that the optimal tariff level on imports is higher when the foreign exporting firm is vertically separated than when it is vertically integrated. As suggested in Eqs. (15.2) and (29.2), the fact that the optimal tariff level under foreign vertical-separation is higher than that under foreign vertical-integration reduces the incentive for foreign upstream manufacturer to choose vertical separation. Lemma (1) and (2) imply that each downstream retailer produce more output under vertical integration than under vertical separation regardless of whether the rival firm is vertically integrated or not. This relates to the effective marginal production cost including tariffs. The effective marginal production cost of downstream retailer $i(h, f)$ under vertical integration is $c + \delta t(\delta = 1$ if $i = f$ and $0$ otherwise) while that of downstream retailer under vertical separation is $w_i + \delta t$, which is higher than $c + \delta t$ irrespective of rival firm’s organizational structure.

We now turn to the firms’ choice of vertical organization-structure at stage 0 of the game. Table 1 represents the payoff matrix of each upstream manufacturer (or integrated firm) for possible organizational regime.

| $h$ | $f$ | Integration | Separation |
|-----|-----|-------------|------------|
| Integration | $\Pi_{VI}^{h*}$, $\Pi_{VI}^{f*}$ | $\Pi_{FS}^{h*}$, $\Pi_{FS}^{f*}$ |
| Separation | $\Pi_{HS}^{h*}$, $\Pi_{HS}^{f*}$ | $\Pi_{VS}^{h*}$, $\Pi_{VS}^{f*}$ |

In Table 1, the following inequalities hold for all $b \in (0,1)$ and $n \in (0,1)$ (the constants $A_8$ and $A_9$ are given in Appendix 1):

\[
\Pi_{VI}^{f*} - \Pi_{FS}^{f*} = \frac{(1-b)b^2(a-c)^2(4b^2+10b^2-4b^4+5b^4-8n+10b^2n-3b^4n)^2[A_8]}{\left(1+b\right)^2(1-k)^2\left[\Psi_{VI}\right]^2\left[\Psi_{FS}\right]^2} > 0, \quad (35.1)
\]

\[
\Pi_{HS}^{f*} - \Pi_{VS}^{f*} = \frac{(1-b)b^2(a-c)^2(16+4b^2-20b^2-4b^4+5b^4-8n+10b^2n-3b^4n)^2[A_9]}{\left(1+b\right)^2(1-k)^2\left[\Psi_{HS}\right]^2\left[\Psi_{VS}\right]^2} > 0, \quad (35.2)
\]
which implies that choosing vertical integration is the dominant strategy for the foreign upstream manufacturer. As in Lemma 1(3), the fact that the optimal tariff level under foreign vertical–separation is higher than that under foreign vertical–integration reduces the incentive for foreign upstream manufacturer to choose vertical separation. As a result, to choose vertical integration is a more profitable than vertical integration for the foreign upstream manufacturer.

**Lemma 2:** Suppose Bertrand competition in an import-competing market with consumption network externalities. If optimal import tariff is implemented by the domestic government, then, for the foreign upstream manufacturer, to choose vertical integration is the dominant strategy.

On the other hand, for the home firm, it holds that

$$
\Pi_{FS}^{V*} - \Pi_{FS}^{I*} = \frac{(1 - b)b^2(a - c)^2(6 + 4b - b^2 - 2n + b^2n)^2[A_{10}]}{(1 + b)^2[\Psi_{FS}]^2[\Psi_{VS}]^2} > (>) 0 \quad \text{if} \quad n > (n^*)^n,
$$

(36.1)

$$
\Pi_{HS}^{V*} - \Pi_{HS}^{I*} = \frac{(1 - b)b^2(a - c)^2(2 - b^2)(3 + 2b - n)^2[A_{11}]}{(1 + b)^2[\Psi_{VI}]^2[\Psi_{VS}]^2} > (>) 0 \quad \text{if} \quad n > (n^*)^n,
$$

(36.2)

where the constants $A_{10}$ and $A_{11}$ are given in Appendix 1. The intuitive understanding is as follows. Suppose that the strength of network effects is lower than the threshold level $n^*$ that satisfies $\Pi_{FS}^{V*}(n^*) = \Pi_{FS}^{I*}(n^*)$. With a two-part tariff contract, the upstream manufacturer can fully extract and obtain all rents of the domestic retailer. In this case, since network effects are sufficiently weak, it is in the interest for the home firm to choose vertical separation, and hence, to charge its retailer a wholesale price higher than the per unit manufacturing costs, because it gives rise to strategic rent shifting effects from the rival firm via the cross effects. This is similar to Bonnano and Vickers (1988), which examines the strategic motive of vertical separation in an oligopolistic market with Bertrand competition.

On the contrary, suppose that the strength of network effects is higher than the threshold level $n^*$ that satisfies $\Pi_{FS}^{V*}(n^*) = \Pi_{FS}^{I*}(n^*)$. If network effects are sufficiently strong, then upstream manufacturer will induce the retailer to behave aggressively in the market in order to gain market share. Vertical integration leads the retailer to be aggressive in the market by eliminating the mark-up over the intermediate-goods, which, in turn, increase the total profits of the retailer and manufacturer. As a result, if $n > n^*$, strategic effects of vertical separation is dominated by network effects and upstream manufacturer finds it optimal to take the strategy of ‘vertical integration’ irrespective of whether the rival firm is vertically separated or integrated.

Here, it is noteworthy that $n^* < n^*$. That is, the threshold level of network strength is higher when he foreign firm is vertically separated than when it is vertically integrated. This can be explained as follows. In our model, vertical separation of the foreign manufacturer has the effect of mitigating the competition pressure in the domestic market since choosing vertical
Separation (i.e., letting the wholesale price be high above per-unit manufacturing cost) results in higher retail price in the domestic market than choosing vertical integration. This means that the strategic rent shift effects by home firm’s vertical separation is greater when the foreign firm is vertically separated than when vertically integrated. As a result, the threshold level of network strength, where the home firm chooses vertical integration as its organizational structure, is higher under foreign firm separation than under foreign firm integration. If the strength of the network effect is moderate level, i.e., \( n \in (n^+, n^*) \), then the strategy of the home firm with respect to the choice of vertical organization structure depends on rival’s strategy. If the rival firm, i.e., foreign upstream manufacturer, chooses vertical integration (resp. separation), then the home firm chooses vertical integration (resp. separation) as its organizational structure.

Figure 1 shows the curves \( n^+ \) and \( n^* \) on the space of \((b, n)\). Because \( n^+ \) and \( n^* \) do not cross in the domain, the area of \((b, n)\) is divided into three regions. For the home manufacturer, it is the dominant strategy to choose vertical integration (resp. separation) in region A (resp. region B). However, in the region surrounded by curves \( n^+ \) and \( n^* \), the home manufacturer takes the same strategy as its rival firm. That is, if the foreign manufacturer chooses vertical integration (resp. separation), the home firm also chooses vertical integration (resp. separation) as its organizational structure.

**Lemma 3:** There exist threshold values \( n^+ \) and \( n^* \) satisfying \( \Pi_{VI}^{h*}(n^+) = \Pi_{HS}^{h*}(n^+) \) and \( \Pi_{FS}^{h*}(n^*) = \Pi_{FS}^{h*}(n^*) \), respectively. For any given value of \( b \), if \( n \) is sufficiently low (resp. high), i.e., \( n < n^+ \) (resp. \( n > n^* \)), then choosing vertical separation (resp. integration) is the dominant strategy for the home upstream manufacturer. On the other hand, if \( n \in (n^+, n^*) \), then the home firm chooses the same vertical organization structure as the foreign firm.
From Lemma 2 and Lemma 3, the following Proposition is immediate.

**Proposition 1:** We consider an import-competing oligopolistic market consisting of one home firm and one foreign firm that produce network goods. In addition, optimal import tariff is levied by domestic government. With a two-part tariff contract, there exists threshold value \( n^+ \) satisfying \( \Pi_{VI}^h(n^+) = \Pi_{HS}^h(n^+) \). For any given value of \( b \), if \( n > n^+ \), then VI regime (i.e., both home and foreign firms choose vertical integration) is the Nash equilibrium, whereas if \( n < n^+ \), then HS regime (i.e., vertical separation for the home firm and vertical integration for the foreign firm) is the Nash equilibrium.

Proposition 1 contrasts sharply with Ziss (1997), which examines the endogenous determination of vertical structure using export-rivalry model without considering network externalities. Unlike Ziss (1997), in which vertical separation is the dominant strategy under Bertrand competition for both domestic and foreign firms, we have demonstrated that both firms choose vertical integration as their organizational structure if network externalities are sufficiently strong whereas the home firm chooses vertical separation but the foreign firm vertical integration if the network externalities are weak.

There are two reasons for this. First, it is due to the difference of the model. Unlike Ziss (1997), where firms are symmetric in terms of their cost structure under export-rivalry model, in the present model of import-competing market, firms are asymmetric in terms of cost structure due to the trade policy of the domestic country. That is, the imposition of import tariff by the domestic government on imports makes the foreign manufacturer disadvantageous in terms of cost structure against the home firm, which in turn reduces the incentive for the vertical separation of the foreign manufacturer. Second, more importantly, the strength of network externalities matters in determining of vertical organization-structure of firms. This is confirmed by Figure 1 that shows the endogenous choice of vertical structure. In figure, the greater the value of \( n \) at a given value of \( b \), the greater the likelihood that a foreign manufacturer will choose vertical integration as its organizational structure. As an extreme case, if \( n = 0 \) (resp. \( n = 1 \)) the home firm chooses vertical separation (resp. integration) irrespective of the value of \( b \).

Next, let’s look at the relationship between endogenously determined organizational structure and social welfare. The following proposition is obtained.

**Proposition 2:** Social welfare under VI regime (i.e., both home and foreign firms choose vertical integration) is greater than that under HS regime (i.e., vertical separation for the home firm and vertical integration for the foreign firm). That is, \( SW_{VI}^* > SW_{HS}^* \).

Proof: \( SW_{VI}^* - SW_{HS}^* = \frac{(1-b)b^2(3 + 2b - n)^2[A_{12}]}{2[\Psi_{VI}]^2[\Psi_{HS}]^2} > 0 \), where \( A_{12} (> 0) \) is given in Appendix 1.

Proposition 2 implies that if \( n > n^+ \), firm’s behavior based on self-interests to determine its organizational structure is consistent with social optimum but if \( n < n^+ \), these behaviors are
not consistent with the social optimum.

5 Concluding Remarks

In this paper, we have examined the implication of network externalities on the determination of vertical organization—structure of international duopoly, where home and foreign manufacturers compete à la Bertrand in the domestic market. Under the assumption of both two-part tariff contract as a wholesale pricing scheme and optimal import tariff implementation by the domestic government, several key findings are obtained.

First, we have shown that the optimal import tariff imposed by the domestic government is higher when the foreign exporting firm is vertically separated than when it is vertically integrated, which in turn reduces the incentives for the vertical separation of the foreign exporting firm. Second, in relation to the first, it is the dominant strategy to choose vertical integration for the foreign manufacturer as its organizational structure. On the other hand, the vertical structure of the domestic firm depends on the relative magnitude between rent shifting effects and network effects of choosing vertical separation. Therefore, there exists a threshold value of network strength balancing above mentioned trade-off. Given the degree of product differentiation \((b)\), if the strength of network effects is higher (resp. lower) than the threshold level, i.e., \(n > n^+\) (resp. \(n < n^+\)), then the home firm chooses vertical integration (resp. separation) as its organizational structure. As an extreme case, if \(n = 0\) (resp. \(n = 1\)), then the home firm chooses vertical separation (resp. integration) irrespective of the value of \(b\). Third, the social welfare under VI regime (i.e., both home and foreign firms choose vertical integration) is greater than that under HS regime (i.e., vertical separation for the home firm and vertical integration for the foreign firm), implying that if \(n > n^+\), firm’s behavior based on self-interests to determine its organizational structure is consistent with social optimum but if \(n < n^+\), these behaviors are not consistent with the social optimum.

The conclusion of our paper depends largely on critical assumptions, including an exclusive dealing contract in the case of vertical separation, two-part tariff contract as a wholesale pricing, and full ownership in integration. Of the assumptions, two-part tariff contract assumption particularly matters in determining organizational structure. Since upstream firms extract the whole surplus from downstream firms with two-part tariff contract, upstream firms’ profits is the main determinant factor when they choose integration or separation. However, partial acquisitions among vertically related firms are very common between upstream and downstream firms, although their effects have rarely been analyzed. Thus, we need to analyze the incentives of downstream firm as well as direction of acquisition (backward vs. forward). The extension of our model in this regard remains a direction for future research.

Appendix 1

\[
A_0 = 52 + 52b - 51b^2 - 63b^3 + 5b^4 + 19b^5 + 4b^6 - 2(2 + b)(2 - b^2)(5 - 3b^2)n + 2(2 - b^2)^2 n^2,
\]

\[
A_1 = 156 + 84b - 251b^2 - 137b^3 + 125b^4 + 69b^5 - 18b^6 - 10b^7 - (172 + 52b - 233b^2 - 63b^3 + 91b^4 + 19b^5 - 8b^6)n + 2\left(2 - b^2\right)\left(16 + 2b - 10b^2 - b^3\right) n^2 - 2\left(2 - b^2\right)^2 n^3, 
\]
A_2 = 52 + 52b - 27b^2 - 31b^3 + b^4 + 3b^5 - 2n\left(2 - b^2\right)^2 + 4b^2 - b^3 + 10 + 5b - 4b^2 - b^3 + 2n^2\left(2 - b^2\right)^2,$

A_3 = 312 + 168b - 482b^2 - 230b^3 + 235b^4 + 89b^5 - 35b^6 - 7b^7

\quad - n\left(344 + 104b - 510b^2 - 114b^3 + 255b^4 + 37b^5 - 43b^6 - 3b^7\right)

\quad + n^2\left(128 + 16b - 184b^2 - 16b^3 + 88b^4 + 4b^5 - 14b^6\right) - 2n^3\left(2 - b^2\right)^3,$

A_4 = 416 + 416b - 968b^2 - 1032b^3 + 786b^4 + 922b^5 - 256b^6 - 350b^7 + 27b^8 + 48b^9

\quad - n\left(320 + 160b - 800b^2 - 392b^3 + 732b^4 + 348b^5 - 290b^6 - 132b^7 + 42b^8 + 18b^9\right)

\quad + n^2\left(64 - 160b^2 + 148b^4 - 60b^6 + 9b^8\right),

A_5 = 1248 + 672b - 3400b^2 - 1816b^3 + 3390b^4 + 1786b^5 - 1462b^6 - 754b^7 + 230b^8 + 115b^9

\quad - n\left(1376 + 416b - 3576b^2 - 1032b^3 + 3398b^4 + 922b^5 - 1398b^6 - 350b^7 + 211b^8 + 48b^9\right)

\quad + n^2\left(512 + 64b - 1280b^2 - 16b^3 + 1168b^4 + 148b^5 - 460b^6 - 60b^7 + 66b^8 + 9b^9\right)

\quad - n^3\left(64 - 160b^2 + 148b^4 - 60b^6 + 9b^8\right),

A_6 = 416 + 416b - 776b^2 - 776b^3 + 466b^4 + 442b^5 - 108b^6 - 70b^7 + 15b^8

\quad - n\left(320 + 160b - 736b^2 - 328b^3 + 604b^4 + 220b^5 - 206b^6 - 48b^7 + 24b^8\right)

\quad + n^2\left(64 - 160b^2 + 148b^4 - 60b^6 + 9b^8\right),

A_7 = 2496 + 1344b - 6460b^2 - 3280b^3 + 6452b^4 + 2748b^5 - 2738b^6 - 862b^7 + 470b^8 + 60b^9

\quad - 25b^{10} - n\left(2752 + 832b - 7504b^2 - 1968b^3 + 7748b^4 + 1660b^5 - 3714b^6 - 582b^7 + 796b^8

\quad + 70b^9 - 55b^{10}\right) + n^2\left(1024 + 128b - 2880b^2 - 320b^3 + 3136b^4 + 296b^5 - 1644b^6 - 120b^7

\quad + 412b^8 + 18b^9 - 39b^{10}\right) - n^3\left(128 - 384b^2 + 456b^4 - 268b^6 + 78b^8 - 9b^{10}\right),

A_8 = 48 - 72b^2 + 39b^4 - 8b^6 - 4n\left(4 + b^2 + 2b^4\right) - 2n^2\left(18 - 30b^2 + 11b^4\right) + n^3\left(2 - b^2\right)

\quad \left(12 - 8b^2 - 2n + b^2\right),

A_9 = 1536 - 4608b^2 + 5152b^4 - 2496b^6 + 398b^8 + 25b^{10} - n\left(512 - 1024b^2 + 448b^4 + 344b^6

\quad - 348b^8 + 80b^{10}\right) - n^2\left(1152 + 3712b^2 + 4616b^4 - 2780b^6 + 816b^8 - 94b^{10}\right) + n^3\left(768 - 2304b^2

\quad + 2704b^4 - 1552b^6 + 436b^8 - 48b^{10}\right) - n^4\left(128 - 384b^2 + 456b^4 - 268b^6 + 78b^8 - 9b^{10}\right),

A_{10} = -960b^2 + 1952b^4 - 1264b^6 + 222b^8 + 25b^{10} + 4n\left(2 - b^2\right)\left(288 - 536b^2 + 360b^4 - 117b^6

\quad + 20b^8\right) - 2n^2\left(2 - b^2\right)\left(672 - 1440b^2 + 1122b^4 - 378b^6 + 47b^8\right) + 4n^3\left(2 - b^2\right)^2

\quad \left(4 + b - 2b^2\right)\left(4 - 2b^2\right) - n^4\left(2 - b^2\right)^3\left(4 - 3b^2\right)^2,

A_{11} = -480b^2 + 1184b^4 - 1096b^6 + 455b^8 - 72b^{10} + 4n\left(288 - 728b^2 + 704b^4 - 311b^6 + 53b^8

\quad - 2n^2\left(672 - 1760b^2 + 1746b^4 - 778b^6 + 131b^8\right) + 4n^3\left(2 - b^2\right)\left(4 - 3b^2\right)\left(16 - 21b^2 + 7b^4\right)

\quad - n^4\left(2 - b^2\right)^2\left(4 - 3b^2\right)^2,
\[ A_{12} \equiv (4-b^2)(3-2b^2)(8-5b^2)(48-68b^2+23b^4)-n\left(5376-14528b^2+14848b^4-7028b^6+1473b^8-96b^{10}\right)+n^2\left(2-b^2\right)(1024-2064b^2+1370b^4-327b^6+18b^8)-n^3\left(2-b^2\right)^2(64-88b^2+27b^4). \]

Appendix 2

The net effects of import tariff on producer's surplus are positive. By differentiating \( \Pi^h_{VS}[t; y, n] \) in terms of \( t \), we obtain

\[
\frac{\partial \Pi^h_{VS}}{\partial t} = \left(w^h_{VS} - c\right) \frac{\partial x^h}{\partial p^h} \left( \frac{\partial p^h}{\partial w^f} \frac{\partial w^f_{VS}}{\partial t} + \frac{\partial p^f}{\partial t} \right) + \left(p^h_{VS} - c\right) \frac{\partial x^h}{\partial p^f} \left( \frac{\partial p^f}{\partial w^f} \frac{\partial w^f_{VS}}{\partial t} + \frac{\partial p^f}{\partial t} \right)
\]

\[
= \left(w^h_{VS} - c\right) \frac{\partial x^h}{\partial p^h} \left( \frac{\partial w^f_{VS}}{\partial t} + 1 \right) + \left(p^h_{VS} - c\right) \frac{\partial x^h}{\partial p^f} \left( \frac{\partial w^f_{VS}}{\partial t} + 1 \right)
\]

Considering \( \left(w^h_{VS} - c\right) \frac{\partial x^h}{\partial p^h} = -\frac{b}{2} \left(p^h_{VS} - c\right) \frac{\partial x^h}{\partial p^f} \) holds from Eq. (29.1), the above equation is reduced to

\[
\frac{\partial \Pi^h_{VS}}{\partial t} = \frac{1}{2} \left(p^h_{VS} - c\right) \left(1 + \frac{\partial w^f_{VS}}{\partial t}\right) \frac{\partial x^h}{\partial p^f} > 0.
\]

Appendix 3

\[
x^{h*}_{VI} - x^{h*}_{HS} = \frac{2b^2(1-b)(2-b^2)(3+2b-n)(6-3b^2-2n)(a-c)}{\Psi^h_{VI} \Psi^h_{HS}} > 0,
\]

\[
x^{h*}_{FS} - x^{h*}_{VS} = \frac{4(1-b)b^2(6-4b-2n+2b^2)(6+4b-b^2-2n+b^2n)(a-c)}{\Psi^h_{FS} \Psi^h_{VS}} > 0,
\]

\[
x^{f*}_{VI} - x^{f*}_{FS} = \frac{2b^2(2-b^2-n)\left[(1-b^2)(3+b-n)+(1-n)\right] (a-c)}{(1+b)\Psi^h_{VI} \Psi^h_{FS}} > 0,
\]

\[
x^{f*}_{HS} - x^{f*}_{VS} = \frac{2b^2(4-3b^2)(4-3b^2-2n+b^2n)\left[8-10b^2+3b^4\right](1-n)+2(1-b^2)(4+2b-b^2)\left(a-c\right)}{(1+b)\Psi^h_{HS} \Psi^h_{VS}} > 0,
\]

\[
x^{f*}_{FS} - x^{f*}_{VI} = \frac{(1-b)b^2(1-n)(4-b^2-2n+b^2n)\left[1-b^2\right](3+b-n)+(1-n)^2 (a-c)}{\left(2-b^2\right)\Psi^h_{FS} \Psi^h_{VI}} > 0,
\]

\[
x^{f*}_{VS} - x^{f*}_{HS} = \frac{(1-b)b^2(1-n)[8-10b^2+3b^4](1-n)+2(1-b^2)(4+2b-b^2)\left[8-10b^2+3b^4\right](1-n)+2(4-b^2-b^4) (a-c)}{\Psi^h_{VS} \Psi^h_{HS}} > 0.
\]
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