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PII: S1090-9443(14)00016-7
DOI: http://dx.doi.org/10.1016/j.rie.2014.03.001
Reference: YREEC584

To appear in: Research in Economics

Received date: 5 January 2014
Revised date: 10 March 2014
Accepted date: 10 March 2014

Cite this article as: Leonard F.S. Wang, Jen-yao Lee, Ranking the Optimum tariff and the Maximum Revenue Tariff in Vertically Related Markets, Research in Economics, http://dx.doi.org/10.1016/j.rie.2014.03.001

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Ranking the Optimum tariff and the Maximum Revenue Tariff in Vertically Related Markets

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Second Revision: March 11, 2014

Abstract

This paper firstly shows that in a vertically related industry with either domestic upstream monopolist or foreign upstream monopolist, when the upstream firm adopts uniform input pricing, the optimum-welfare tariff is higher than the maximum-revenue tariff, if the number of foreign competitors is sufficiently large. Secondly, when domestic upstream monopolist adopts discriminatory input pricing, the maximum-revenue tariff is higher than the optimum-welfare tariff. Thirdly, when foreign upstream monopolist adopts discriminatory input pricing, the optimum-welfare tariff will exceed the maximum-revenue tariff if the sizes of domestic and foreign firms become more unequally distributed.

Keywords: input pricing, vertical structure, tariff ranking

JEL classifications: F13, H21, L13

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+We would like to thank the editor and two anonymous referees for their useful comments and constructive suggestions. The work described in this paper was supported by the National Science Council of Taiwan under Grant NSC 99-2410-H-390-006-MY3.
1. Introduction

Whether to apply maximum revenue tariffs or optimum welfare tariffs is interesting and should be deliberated because the tariff revenue is an important income source of a government before building up an efficient tax system. A government may adjust its goal from maximum revenue to optimum-welfare tariff when the country is moving toward more market opening and social welfare concern along with industry adjustment and the need for fiscal reform to comply with the guideline of WTO.

Taking Taiwan economy as example, its superb performance in last century has been called “Economic Miracle”, even though it is an export-oriented island economy without having much natural resources and vital intermediate inputs. In 1960’s, with abundant labor force the government adopted “Import-Substituting” development strategy and established its first “Export-Processing Zone” in Kaohsiung in 1966 preparing for leaping into next “Export-Promoting” stage. For 30 years since 1950, the government imposed higher import-tariff rate to collect tariff revenue on imported goods supporting country fiscal budget for subsidizing its agricultural sector and investing public infrastructure and heavy manufacturing sector. Because Taiwan does not have enough raw materials, for example, like corn to feed hog, sorghum bicolor to brew liqueur in agricultural sector, which may need to be supplied partly by foreign firm before self-supported; similarly, for many manufacture commodities, in early stage of radio, camera and automobile production, the intermediate parts and assembly equipments are all imported mainly from Japan and U.S.A.

The above examples illustrated the vertical production structure and the higher maximum-revenue tariff concurrently existed for a certain period of time. Moving into 1980 and 1990, the development strategy of Taiwan economy switched to liberalization and internationalization decades, and fiscal reform was also undertaken
to reduce its heavy dependence on the maximum-revenue tariff. The development stories of the country provide us the real-world scenario and motivate us to address the issue of adjusting its goal from maximum revenue to optimum-welfare tariff in fiscal reform.

There are few papers in the literature exploring international vertical organization of firms and global sourcing. For example, McLaren (2000) analyzed the effects of international openness on vertical integration and argued that vertical integration can confer a negative externality, by thinning the market for inputs, facilitating leaner, less integrated firms, thus providing gains from international openness which is quite different from those that are familiar from trade theory. Hummelsa et al., (2001) observed and argued that production processes increasingly involve a sequential, vertical trading chain stretching across many countries, with each country specializing in particular stages of a good’s production sequence. Antra’s and Helpman (2004) presented a North-South model of international trade in which differentiated products are developed in the North. On the basis of productivity and sectoral characteristics, firms decide whether to integrate into the production of intermediate inputs or outsource them. Rossini (2007) showed that in an international duopoly setting, with vertical restraints due to competition or trade policies, vertically disintegrated (VD) firms operate independently in distinct stages and countries becoming the privately preferred mode. Recently, Schwarz and Suedekum (2013) developed a theory of a firm in an incomplete contracts environment which decides on the complexity, the organization, and the global scale of its production process. In particular, it provides an explanation why many firms choose hybrid sourcing and have both outsourced and integrated suppliers.¹

¹ Airbus in January 2013 announced that the company has implemented a new production organization in managing the steep and steady ramp-up of industrial activities to meet continued strong demand, while also achieving higher performance levels across the company’s series and development
In a traditional tariff analysis without incorporating international vertical organization of firms, Johnson (1951-1952) argued that the maximum-revenue tariff is higher than the optimum-welfare tariff because a ‘large’ country could change the terms of trade in order to raise its social welfare level. Tower (1977) used a two-commodity model to demonstrate that under certain conditions, the maximum-revenue tariff will exceed the optimum-welfare tariff. From the strategic trade aspect, Brander and Spencer (1984) have shown that government could improve its terms of trade through tariffs in an oligopoly market and take a leading position to transfer a foreign firm’s revenue to a domestic firm by using tariff as a strategic instrument. Collie (1991) demonstrated that in a Cournot quantity competition oligopoly market with a linear demand function and an asymmetric marginal cost, the optimum-welfare tariff will be higher than the maximum-revenue tariff if the domestic firm’s marginal cost is relatively lower than that of the foreign firm. Larue and Gervais (2002) further allowed asymmetric numbers of domestic and importing firms, and showed that if the numbers of producing firms and importing firms are the same, the maximum-revenue tariff is higher than the optimum-welfare tariff. Clarke and Collie (2006) found that in a Bertrand price competition model, the optimum-welfare tariff is higher than the maximum-revenue tariff when the product is highly substitutable.

Recently, Wang et al. (2009) introduced market share delegation in a trade duopoly context, and demonstrated that the home government unambiguously imposes a higher optimum-welfare tariff than maximum-revenue regardless of the programmes. The new organization aims to accomplish the goals through further integration, full cross-functional alignment and even more teamwork in Airbus’ production activities.
form of delegation. Wang et al. (2010) examined the tariff ranking issue under a linear mixed oligopoly model with foreign competitors and asymmetric costs. In particular, they demonstrated that under Cournot competition and Stackelberg public follower, when the sizes of domestic private and foreign private firms become more unequally distributed, the optimum-welfare tariff will exceed the maximum-revenue tariff; however, under Stackelberg public follower, the maximum-revenue tariff may be higher than the optimum-welfare tariff.2

The above literatures did not consider market power of the input suppliers.3 This may be appropriate in some real world situations, yet the input markets are often imperfectly competitive, thus giving market power to the input suppliers. For example, the industries such as iron and steel, petroleum refining, petrochemicals and certain other chemicals, cement, paper and pulp and sugar refining, which produce inputs for several final goods, are characterized by imperfect competition.

Before the 1990s, strategic trade policies under imperfect competition had focused on the horizontal aspects of market structures. Many papers in recent years focused on the strategic effects of trade policies in vertically-related markets.4 For example, Spencer and Jones (1992) investigated whether an import tariff on an intermediate input may reduce the input price under a model with a vertically integrated market structure. Bernhofen (1997) examined strategic export intervention

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2 See, Wang and Lee (2010) and Wang et al. (2011) examined the optimum-welfare tariff and the maximum-revenue tariff in mixed market with partial privatization and considered the order of firms’ move. Wang and Lee (2012) demonstrated that in a regulated entry oligopoly with asymmetric costs, when the marginal cost of the domestic firms exceeds a critical value, the maximum revenue tariff is higher than the optimum-welfare tariff; under free entry of domestic firms with asymmetric costs, when the fixed cost gets larger and the domestic firms become fewer, the difference between the optimum-welfare tariff and the maximum-revenue tariff becomes larger.

3 Katz (1987) and DeGraba (1990) pointed out that government regulation may require the upstream agent to charge a uniform price to the asymmetric downstream agents. It is well-known from Yoshida (2000) that an upstream agent prefers price discrimination than uniform pricing in the presence of asymmetric downstream agents.

in a final-good industry which uses an intermediate good supplied by a foreign monopolist. And because an export tax-cum-subsidy leads to horizontal and vertical rent extraction, the optimal government trade policy in the final good market is shown to depend on the pricing schemes, uniform or discriminatory pricing, employed by the intermediate good producer. Ishikawa and Spencer (1999) suggested that export subsidies that were intended to shift rents from foreign producers to domestic producers of a final good may also serve to shift rents from foreign firms supplying an intermediate input, thereby weakening the incentive for the subsidy. They argued that the optimal export subsidy could therefore be reversed if intermediate good firms are in foreign countries.

In this paper, we based on the real-world country case during the development stage and fiscal reform of developing countries toward more market opening and social welfare concern formulating a vertically related market with a domestic upstream firm or a foreign upstream firm, who adopts two pricing schemes, uniform pricing and discriminatory pricing. It shows that when the upstream firm adopts uniform input pricing, the optimum-welfare tariff is higher than the maximum-revenue tariff regardless the location of upstream monopolist. When the local upstream firm adopts discriminatory input pricing, the maximum-revenue tariff is higher than the optimum-welfare tariff. But, if the upstream monopolist is located in the foreign country, and when the sizes of domestic and foreign firms become more unequally distributed, the optimum-welfare tariff will exceed the maximum-revenue tariff.

The remainder of this paper is organized as follows. Basic modeling is provided in Section 2. Section 3 contains the analysis of tariffs ranking under uniform pricing, with an upstream firm located in the home or the foreign country, while in Section 4 we explore the case of discriminatory pricing and tariffs ranking. Section 5 concludes
the paper.

2. The basic model

The Downstream market

Consider a domestic downstream market for a homogeneous good produced by \( n \) domestic firms and \( m \) foreign firms. The linear demand function is \( P = a - Q \). The supply equation is given by 
\[
Q = \sum_{i=1}^{n} q_{i} + \sum_{j=1}^{m} q_{j},
\]
where \( q_{i} \) and \( q_{j} \) denote, respectively, domestic firm’s and foreign firm’s productions. Suppose the domestic firms and the foreign firms require one unit of intermediate good from a domestic or foreign upstream firm to produce the one unit of the output. The input price of the domestic firms and the foreign firms are \( w_{i} \) and \( w_{j} \), respectively. The domestic government imposes a specific tariff on the foreign firm and the tariff rate is \( t \). The profits of the domestic downstream firms and the foreign downstream firms are given by:
\[
\pi_{i} = (P - w_{i})q_{i} \quad (1) \\
\pi_{j} = (P - w_{j} - t)q_{j} \quad (2)
\]

In the downstream market, the firms are competing with quantity, and profits are realized in Cournot-Nash equilibrium.

The Upstream market

The upstream market has a monopolist who either located in the home or the foreign country, who is the only supplier of the intermediate good. In accordance with the industrial organization literature, we distinguish two pricing schemes that are chosen by the monopolist: firstly, price discrimination between the domestic downstream firms and foreign downstream firms, and secondly, uniform pricing.
The profit of the upstream monopolist is

\[ V = n(w_i - k)q_i + m(w_j - k)q_j \]  \hspace{1cm} (3)

where \( k \) is the marginal cost of the upstream firm who produce one unit of intermediate good. Under uniform pricing, the upstream monopolist will choose a single price \( w \) that maximizes

\[ V = n(w - k)q_i + m(w - k)q_j \]  \hspace{1cm} (3')

**Tariff policy**

The government decides tariff policies, given its knowledge about the implications of their interventions on the firms’ pricing and output decisions. Two types of objective functions are considered by the government: firstly, revenue maximization, and secondly, welfare optimization. The tariff revenue is given as

\[ R = t m q_j \]  \hspace{1cm} (4)

And the social welfare with domestic upstream firm and with foreign upstream firm is, respectively,

\[ W = CS + n \pi_i + V + tm q_j \]  \hspace{1cm} (5)

\[ W = CS + n \pi_i + tm q_j \]  \hspace{1cm} (5')

where the consumer surplus is given by \( CS = \frac{1}{2}(\sum_{i=1}^{n} q_i + \sum_{j=1}^{m} q_j)^2 \).

In this model, we construct a three stages game. In the first stage of the game, the government decides tariff policies, optimum-welfare and maximum-revenue tariff. In the second stage, the upstream firm chooses its pricing strategies, uniform pricing and discriminatory pricing. In the third stage, the downstream firms play with Cournot competition. Backward induction is used to solve the sub-game perfect Nash equilibrium.
3. Uniform pricing and tariffs ranking

In this section, the case of uniform input pricing is analyzed in order to see the ranking of optimum-welfare tariff and maximum-revenue tariff.

In the market stage, the \((m + n)\) firms choose outputs to maximize their profits,

\[
\frac{\partial \pi}{\partial q_i} = 0 \quad \text{and} \quad \frac{\partial \pi}{\partial q_j} = 0 .
\]

From the first-order conditions, we have

\[
q_i = \frac{a - w_i - m(w_i - w_j - t)}{1 + m + n}
\]

(6)

\[
q_j = \frac{a - w_j - t + n(w_i - w_j - t)}{1 + m + n}
\]

(7)

Note that from Eq. (7), when \(t > \hat{t} \equiv \frac{a - w_i + n(w_i - w_j)}{1 + n}\), \(q_j = 0\).

In the input-pricing stage, after substituting Eqs. (6) and (7) into (3) and letting \(w_i = w_j = w\), we have

\[
V = \frac{(w - k)[(a - w)(m + n) - mt]}{1 + m + n}.
\]

We then differentiate \(V\) with respect to \(w\), that gives the input price and the profit of upstream firm\(^5\):

\[
w = \frac{1}{2} \left( a + k - \frac{mt}{m + n} \right)
\]

(8)

\[
V = \frac{[(a - k)(m + n) - mt]^2}{4(m + n)(1 + m + n)}.
\]

Differentiating \(w\) and \(V\) with respect to \(t\), we obtain

\[
\frac{\partial w}{\partial t} < 0 , \quad \frac{\partial V}{\partial t} < 0 .
\]

Assuming that \(a > k\) for the positive outputs of downstream firms, it shows that when the tariff rate is increasing, the derived demand of intermediate good is decreasing, and the input price and the profit of the upstream firm will decrease.

\(^5\) Pinopoulos (2011) showed that when entry is endogenously dependent on profitability conditions, the upstream supplier’s price setting behavior depends on the number of operative firms in the final goods market.
Substituting Eq. (8) into (1), (2), (6) and (7), we have

\[ q_i = \frac{(a-k)(m+n) + (1+2m+2n)mt}{2(m+n)(1+m+n)} \]

\[ q_j = \frac{(a-k)(m+n) - [m+2mn+2n(1+n)]t}{2(m+n)(1+m+n)} \]

\[ Q = \frac{(a-k)(m+n) - mt}{2(1+m+n)} \]

\[ \pi_i = \frac{(a-k)(m+n) + (1+2m+2n)mt}{2(m+n)(1+m+n)}^2 \]

\[ \pi_j = \frac{(a-k)(m+n) - [m+2mn+2n(1+n)]t}{2(m+n)(1+m+n)}^2 \].

Differentiating the total output, the profit of domestic and foreign downstream firms with respect to \( t \), we obtain

\[ \frac{\partial Q}{\partial t} < 0, \quad \frac{\partial \pi_i}{\partial t} > 0, \quad \frac{\partial \pi_j}{\partial t} < 0. \]

That is, when the tariff is increasing, the total output and the profit of foreign firms are decreasing, but the profit of domestic firms is increasing.

### 3.1 Domestic upstream firm

In the tariff policy stage, the domestic government maximizes social welfare or tariff revenue. In this case, social welfare is given as \( W = CS + n\pi_i + V + tmq_j \).

Solving the optimization problem for tariff rates, we have

\[ \frac{dR}{dt} = m\left[ q_i^t + \frac{dq_i}{dt} \right] \]

\[ \frac{dW}{dt} = Q\left[ n\frac{dq_i}{dt} + m\frac{dq_j}{dt} \right] + n\left[ q_i\left( \frac{dP}{dt} - \frac{dw_i}{dt} \right) + (P - w_i)\frac{dq_i}{dt} \right] \]

\[ + \frac{dV}{dt} + m\left[ q_j^t + \frac{dq_j}{dt} \right] \]

The first term in Eq. (10) is **consumer-surplus effect**, which is negative, means that increasing tariff will decrease consumer surplus. The second term denotes the **horizontal profit-shifting effect**, indicating the impact of tariff on its profit is positive,
which is simply because tariffs raise the marginal cost of foreign firms resulting in the profit shifts to domestic private firms. Under uniform input pricing, \( w_i = w \) and \( dw/dt < 0 \) which leads a higher horizontal profit-shifting effect. The third term is the vertical rent-extraction effect which reflects the effect of tariff via change in input price which is negative; due to that the derived demand of intermediate good is decreasing in tariff, and the domestic upstream firm’s profit will be declined. Clearly, the vertical rent-extraction effect is influenced by the imposition of tariff. The fourth term is the tariff revenue effect which could either be positive or negative depending on the relative magnitude of the consumer-surplus effect, the horizontal profit-shifting effect and the vertical rent-extraction effect. In a perfectly competitive market and when the host country is “large” without vertical market structure, because both horizontal profit-shifting effect and vertical rent-extraction effect are zero, the tariff could increase domestic welfare due to the tariff-revenue effect (terms-of-trade effect); because the consumer-surplus effect is negative and the tariff-revenue effect is positive, we have the result obtained by Johnson (1951-1952), the maximum-revenue tariff is higher than the optimum-welfare tariff. Accordingly, when the sum of the consumer-surplus effect, the horizontal profit-shifting effect and the vertical rent-extraction effect is positive, and the tariff-revenue effect is negative, the optimum-welfare tariff exceeds the maximum-revenue tariff. Hence, the ranking of the maximum-revenue tariff and the optimum-welfare tariff under imperfect competition depends on the input pricing scheme adopted by the intermediate good producer.

After substituting Eqs. (6), (7), and (8) into (4) and (5), we then take the differentiation with respect to \( t \), that gives the following tariffs: (Superscript UD represents the equilibrium of uniform input pricing with domestic upstream firm)
Welfare-maximizing tariff is 
\[ t_{W}^{UD^*} = \frac{(a-k)(m+n)[(m+n)(3n-m)+2n]}{H_1} \]

where \( H_1 = m^3 + 8n^2(1+n)^2 + 2m^2(1+n)(1+4n) + mn[2(25+16n)+8] > 0 \). We have \( t_{W}^{UD^*} > 0 \), if \( n > \bar{n} \equiv \frac{1}{2} \sqrt{1+2m+4m^2} - 1 - m \). It indicates that the domestic government should impose tariff to protect domestic firms only when there are enough domestic firms; otherwise, it should choose to provide production subsidy to the foreign firms who will increase demand for intermediate good from domestic upstream firm.

Revenue-maximizing tariff is 
\[ t_{R}^{UD^*} = \frac{(a-k)(m+n)}{4n(1+n) + m(2 + 4n)} \]

Comparing these two tariff rates, we have:
\[ \Delta^{UD} = t_{W}^{UD^*} - t_{R}^{UD^*} = \frac{(a-k)(m+n)F_1}{2[2m+2mn+2n(1+n)]H_1} \]

where \( F_1 = 4n^3(1+n) - m^3(3+4n) - mn[4 + (3-4n)n] - 2m^2[1 + n(5+2n)] \).

The sign of \( \Delta^{UD} \) depends on the sign of \( F_1 \). We have \( F_1 > 0 \) if \( m > \bar{m} \),

where \( \bar{m} = \sqrt{2}(4+4n+41n^2+80n^3+64n^4)}{3(3+4n)^2} + \frac{\sqrt{\Omega}}{3\sqrt{2}(3+4n)} - \frac{2(1+5n+2n^2)}{3(3+4n)} \)

\( \Omega \equiv -16 - 24n + 234n^2 + 694n^3 + 1584n^4 + 1920n^5 + 1024n^6 \)
\[ + 6\sqrt{3}n(3+4n)\sqrt{-16 - 24n - 73n^2 - 18n^3 + 112n^4 + 128n^5} \]

We obtain the following proposition.

**Proposition 1:** In a vertically related industry with domestic upstream monopolist adopts uniform input pricing, the optimum-welfare tariff is higher than the maximum-revenue tariff, if the number of the foreign competitors is sufficiently large.

Although vertical rent-extraction effect is negative, but due to that the uniform pricing is adopted by the upstream firm, the higher tariff reduces the input price, \( dw/dt < 0 \) which leads to a higher horizontal profit-shifting effect. Note that the sum
of consumer-surplus effect, horizontal profit-shifting effect and vertical rent-extraction effect is positive, and because the tariff-revenue effect is negative, the optimum-welfare tariff exceeds the maximum-revenue tariff, if the number of the foreign firm is sufficiently large.

3.2 Foreign upstream firm

When the upstream firm is located in the foreign country, social welfare is given as \( W = CS + n\pi_i + tmq_j \).

The social welfare function maximized by the domestic government is \((5')\). Solving the optimization problem, Eq. \((5')\) is differentiated with respect to \( t \) and obtain

\[
\frac{dW}{dt} = Q\left[ n \frac{dq_i}{dt} + m \frac{dq_j}{dt} \right] + n \left[ q_i \left( \frac{dP}{dt} - \frac{dw_i}{dt} \right) + (P - w_i) \frac{dq_i}{dt} \right] + m \left[ q_j + t \frac{dq_j}{dt} \right] \tag{10'}
\]

From Eq. \((10')\), the vertical rent-extraction effect in this case is zero.

Substituting Eqs. (6), (7), and (8) into (4) and \((5')\), we then take differentiation with respect to \( t \), that gives the tariff rates: (Superscript UF represent the equilibrium of uniform input pricing with foreign upstream firm)

Comparing welfare-maximizing tariff and revenue-maximizing tariff, we have:

\[
\Delta t^{UF} = t^{UF*}_w - t^{UF*}_R = \frac{(a-k)(m+n)F_2}{2[m+2mn+2n(1+n)]H_2}
\]

where \( H_2 = 3m^3 + 8n^2(1+n)^2 + 2m^2(2+7n+4n^2) + mn(10+27n+16n^2) > 0 \) and \( F_2 = 10m^2n(1+2n) + 4n^2(1+n)(2+3n) + m^3(-1+4n) + mn(1+4n)(6+7n) \). Because \( n \) is greater than or equal to 1, we obtain \( F_2 > 0 \) and \( \Delta t^{UF} > 0 \).

We have the following proposition.
Proposition 2: In a vertically related industry with foreign upstream monopolist adopts uniform input pricing, the optimum-welfare tariff is higher than the maximum-revenue tariff.

When the upstream firm is located in the foreign country, vertical rent-extraction effect simply does not exist. Hence, when the uniform pricing is adopted by the foreign upstream firm, \( \frac{dw}{dt} < 0 \) which leads to a higher horizontal profit-shifting effect. The optimum-welfare tariff is higher than the maximum-revenue tariff.

4. Discriminatory pricing and tariffs ranking

In this section, we examine the tariffs ranking under discriminatory input pricing. In the input-pricing stage, we substitute Eqs. (6) and (7) into (3), and then take the first-order derivative of \( V \) with respect to \( w_i \) and \( w_j \), that gives the input prices and the profit of upstream firm:

\[
w_i = \frac{a + k}{2} \tag{11}
\]

\[
w_j = \frac{a + k - t}{2} \tag{12}
\]

\[
V = \frac{(a - k)^2(m + n) - 2(a - k)mt + m(1 + n)t^2}{4(1 + m + n)}
\]

Substituting Eq. (8) into (1), (2), (6) and (7), we have

\[
q_i = \frac{(a - k) + mt}{2(1 + m + n)}
\]

\[
q_j = \frac{(a - k) - (1 + n)t}{2(1 + m + n)}
\]

\[
Q = \frac{(a - k)(m + n) - mt}{2(1 + m + n)}
\]

\[
\pi_i = \left[ \frac{(a - k + mt)}{2(1 + m + n)} \right]^2
\]

\[
\pi_j = \left[ \frac{(a - k) - (1 + n)t}{4(1 + m + n)} \right]^2.
\]
4.1 Domestic upstream firm

When the discriminatory input pricing is adopted by the domestic upstream firm, \( dW_i/\!dt = 0 \); horizontal profit-shifting effect in discriminatory input pricing case is larger than the case of uniform input pricing.

Substituting Eqs. (6), (7), (11) and (12) into (4) and (5), we then take the differentiation with respect to \( t \), that gives the following tariffs\(^6\): (Superscript DD represents the equilibrium of discriminatory input pricing with domestic upstream firm)

- Welfare-maximizing tariff is  
  \[
  t_w^{DD^*} = \frac{(a-k)(n-m)}{m + 2(1+n)^2} > 0 \text{ if } n>m.
  \]

- Revenue-maximizing tariff is  
  \[
  t_R^{DD^*} = \frac{a-k}{2(1+n)}.
  \]

Comparing these two tariff rates, we have:

\[
\Delta t^{DD^*} = t_w^{DD^*} - t_R^{DD^*} = -\frac{(a-k)[2 + 3m + 2(1+m)n]}{2(1+n)[m + 2(1+n)^2]} < 0
\]

We have the following proposition.

**Proposition 3:** In a vertically related industry with domestic upstream monopolist adopts discriminatory input pricing, the maximum-revenue tariff is higher than the optimum-welfare tariff.

The vertical rent-extraction effect is negative, and due to that the discriminatory pricing is adopted by the upstream firm, \( dW_i/\!dt = 0 \), which leads to a larger horizontal profit-shifting effect. In this case, the sum of the consumer-surplus effect, the horizontal profit-shifting effect and the vertical rent-extraction effect is negative, but the tariff-revenue effect is positive; hence, the maximum-revenue tariff is higher than the optimum-welfare tariff.

\(^6\) The second-order condition is always satisfied.
4.2 Foreign upstream firm

When the upstream firm is located in the foreign country, the social welfare function reduced to \((5')\). Substituting Eqs. (6), (7), (11) and (12) into (4) and \((5')\), we then take the differentiation with respect to \(t\), that gives the following tariffs (Superscript DF represents the equilibrium of discriminatory input pricing with foreign upstream firm)

Welfare-maximizing tariff is \(t_{DF}^{\text{w}} = \frac{(a-k)(2+m+3n)}{m(3+2n) + 4(1+n)^2}\), while

Revenue-maximizing tariff is \(t_{DF}^{\text{r}} = \frac{a-k}{2(1+n)}\).

Comparing these two tariff rates, we have:

\[
\Delta t_{DF}^{\text{r}} = t_{DF}^{\text{w}} - t_{DF}^{\text{r}} = -\frac{(a-k)[m-2n(1+n)]}{2(1+n)[m(3+2n) + 4(1+n)^2]} < 0, \text{ when } m=2n(1+n)
\]

We have the following proposition.

**Proposition 4:** In a vertically related industry with foreign upstream monopolist adopts discriminatory input pricing, and when the sizes of domestic and foreign firms become more unequally distributed, the optimum-welfare tariff will exceed the maximum-revenue tariff.

This result echoes the findings of Larue and Gervais (2002), the vertical rent-extraction effect is zero when the upstream firm located in the foreign country, the term of \(\frac{dV}{dt} = 0\). The sign of the consumer-surplus effect plus the horizontal profit-shifting effect depend on the number of the domestic and foreign firms; when the sizes of domestic and foreign firms become more unequally distributed, the optimum-welfare tariff will exceed the maximum-revenue tariff.
5. Conclusions

Collie (1991) showed that in a linear Cournot duopoly with asymmetric marginal cost, the optimum-welfare tariff will be higher than the maximum-revenue tariff if the domestic firm’s marginal cost is relatively lower than that of the foreign firm. Larue and Gervais (2002) allowed asymmetric numbers of domestic and importing firms, and showed that if the numbers of producing firms and importing firms are the same, the maximum-revenue tariff is higher than the optimum-welfare tariff. This paper re-examines how input pricing policies chosen by the upstream monopolist affects the ranking of the maximum-revenue tariff and the optimum-welfare tariff in a vertically related industry with foreign competition.

Tariff imposed on the final good producer in our model has two effects: a horizontal profit-shifting effect and a vertical rent-extraction effect; hence, the ranking of the optimum-welfare tariff vs. the maximum-revenue tariff depends on the input pricing scheme adopted by the intermediate good producer.

We firstly, showed that in a vertically related industry with either domestic upstream monopolist or foreign upstream monopolist, when the upstream firm adopts uniform input pricing, the optimum-welfare tariff is higher than the maximum-revenue tariff, if the number of foreign competitors is sufficiently large. Secondly, in a vertically related industry with domestic upstream monopolist adopts discriminatory input pricing, the maximum-revenue tariff is higher than the optimum-welfare tariff. Thirdly, when foreign upstream monopolist adopts discriminatory input pricing and the sizes of domestic and foreign firms become more unequally distributed, the optimum-welfare tariff will exceed the maximum-revenue tariff.
References


Research Highlights

► It examines the tariff ranking in oligopoly without and with domestic upstream firm.
► Under domestic upstream discriminatory pricing, the maximum-revenue tariff is higher.
► Otherwise, the optimum-welfare tariff is higher, if the number of foreign firm is large.