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Industry concentration and strategic trade policy in successive oligopoly

by

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Abstract

We study a policy game between exporting and importing countries in vertically linked industries. In a successive international Cournot oligopoly, we let the governments in the importing and exporting countries use tax instruments strategically to shift rents up or down the vertical value-chain. We show that the equilibrium outcome depends crucially on the relative degree of competitiveness in the upstream and downstream parts of the industry. With respect to national welfare, a more competitive upstream industry may benefit an exporting (upstream) country while harming an importing (downstream) country. On the other hand, a more competitive downstream industry may harm exporting countries.

Keywords: Successive oligopoly; strategic trade policy; industry concentration.

JEL Classification: F12; F13; L13

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1 Introduction

Vertical linkages play an important role in international trade, particularly in markets where firms (and ultimately consumers) rely on key intermediate inputs or raw materials that are supplied by dominant exporters in one or a few countries. Trade in natural resources serves as an obvious example. In a policy context, such cross-border vertical linkages naturally lead to a conflict of interest between exporting and importing countries. In the present paper, we consider the policy interaction between exporting and importing countries in an industry that is characterised by successive international oligopoly[1]: upstream oligopolist firms in one or more exporting countries supply a homogeneous good to downstream oligopolist firms in an importing country, where the end-user market is located.

Although our model structure is sufficiently generic to fit a variety of different industries, an interesting – and particularly fitting – example of such an industry structure is the European market for natural gas. The ongoing liberalisation of the market – through the implementation of the so-called Gas Directive[2] – means that the market structure is increasingly taking the shape of a successive oligopoly, with an oligopoly of upstream gas producers and a downstream oligopoly of gas traders.[3] Furthermore, natural gas consumption within the EU relies heavily on supply from a small number of non-EU gas producing countries (Norway, Russia and Algeria).[4]

The presence of imperfect competition in international markets may provide trading countries with an incentive to use trade policy strategically in order to capture foreign rents.[5] In the context of a successive

[1] See e.g. Greenhut and Ohta (1979) and Salinger (1988) for standard models of successive Cournot oligopoly.

[2] The original EU Gas Directive from 1998 specified common rules for the trade, distribution, supply and storage of natural gas. In 2003, an amendment to the directive included further measures to be taken in order to liberalise the European gas market. Details can be found at http://europa.eu.int/comm/energy/gas/index_en.htm.

[3] Boots et al. (2004) model the European gas market as a successive Cournot oligopoly. However, strategic policy issues are not looked into.

[4] See e.g. Austvik (1997), Radetzki (1999) and Percebois (1999) for detailed descriptive analyses of the European natural gas market.

[5] Seminal contributions to the literature on strategic trade policy include Dixit

international oligopoly industry, we analyse how the governments in the exporting and importing countries may use taxes (or subsidies) strategically in order to shift rents up or down the vertical value-chain. In the basic version of our model – with only one exporting country – we characterise the equilibrium of a non-cooperative policy game between the upstream and downstream governments, and show that the equilibrium outcome depends crucially on the relative degree of concentration in the upstream and downstream parts of the industry. We also extend our basic model to allow for upstream supply from two different countries, where the government in the second country may or may not act strategically, which may also affect the policy equilibrium in a non-trivial way.

Although international trade agreements to a certain extent may limit the availability of traditional trade policy instruments, such as export subsidies and import tariffs, there is arguably a wide range of feasible policy instruments that may be used for strategic trade purposes. For example, a country may adopt lax environmental policies – as a substitute for direct subsidies – in order to strengthen the competitive position of domestic firms vis-á-vis their foreign rivals.[6] In our model, we let the policy instrument be a tax (or subsidy) on production in the respective countries, which can be given several different interpretations.[7] In any case, the important feature of the model is that national policy makers can use tax instruments of one or another kind to affect equilibrium market prices, and thus the allocation of industry rents between the countries.[8]

(1984), Brander and Spencer (1985) and Eaton and Grossman (1986).

[6] Seminal contributions to the literature on 'strategic environmental policy' include Conrad (1993), Barrett (1994) and Kennedy (1994).

[7] For example, in our model (with no domestic consumption in the exporting countries), an upstream tax on production is equivalent to an export tax, while a downstream production tax is equivalent to an import tariff levied on the domestic firms. It is also worth noting that a consumption tax would have similar qualitative effects as an import tariff.

[8] In the natural gas example, there is also another policy instrument that may be used strategically in order to extract foreign rents. A key component in the process of liberalising the European gas market is the concept of 'third-party access' (TPA) to gas piplines and transmission networks, where all players have access to the transportation systems on equal non-discriminatory conditions. Since the exporting

We also analyse how the degree of competition in different parts of the industry is likely to affect the policy equilibrium. This has important implications for competition policy and welfare effects of market liberalisation. Given that policy makers act strategically, which country will gain or lose from increased competition in either the upstream or downstream part of the industry? For example, in the process of liberalising the European natural gas market, there is a stated desire from the European Union not only to increase downstream competition, but also to increase competition in the upstream market by trying to break up the sales monopolies of the exporting countries.[9,10] Although downstream firms may stand to lose, this should – in principle – yield a net benefit to the importing countries through increased supply and lower prices. But will this necessarily be the case if the governments in the importing and exporting countries engage in strategic trade policy? And how is the presence of competing exporting countries likely to affect the results? These are some of the key questions analysed in the paper.

Let us now sketch some of our main findings. In our basic version of the model, the non-cooperative policy equilibrium implies a positive upstream tax rate if there is any upstream competition, and a zero tax rate otherwise. The equilibrium downstream tax rate, on the other hand, is positive if, roughly speaking, the downstream market is more competitive than the upstream market, and negative otherwise. This illustrates the conflict of interest between the countries: whereas the government in the exporting country is concerned about maximising upstream revenue net of production costs, the government in the downstream country

and importing countries control different parts of the transmission network, policy makers may have incentives to set the regulated access price strategically, thereby engaging in a regulatory competition game, in order to shift rents up or down the value-chain. In this case, the access price is a de facto tax instrument.

[9] The major gas producer Norway – a non-EU country, but subject to the common competition legislation in the European Economic Area (EEA) – reluctantly accepted to dismantle the Norwegian gas sales monopoly (GFU) after threats of legal actions by the EU Commission (see, e.g., Claes and Fossum, 2002).

[10] Golombek et al. (1998) use a numerical model of the Western European natural gas market to analyse supply-side responses to a more liberalised downstream industry, and find that producing countries have an incentive to break up their sales monopolies. However, strategic trade policy, or any form of tax policy competition between countries, is not an issue.

must balance concerns for rent-extraction from the upstream part of the industry (which requires a positive tax rate) and for stimulating competition in the downstream part of the industry (which requires a negative tax rate). However, supply from a second exporting country introduces an incentive for the upstream governments to subsidise domestic production in order to capture market shares in the export market. In this case, if both upstream governments act strategically, we show that positive upstream tax rates in both countries cannot be part of a policy equilibrium.

Some of our most interesting results regard the welfare effects of increased competition in the different parts of the vertically linked industry. With a single exporting country (or cooperative upstream policy-making), increased upstream competition will actually benefit the exporting country and harm the importing country in the trade policy equilibrium. This has powerful implications for upstream competition policy. By stimulating upstream competition, and instead use a tax instrument to restrict total supply to the downstream market, rents are shifted up the value-chain, which benefits the exporting country. A similar result was shown by Cowan (1989) in a structurally simpler model, but under more general demand assumptions.[11] We extend Cowan's model by introducing a downstream oligopoly in the importing country and the possibility of a second exporting (upstream) country, both of which influence policy incentives in non-trivial ways. We show that the result is robust to the introduction of a second exporting country, conditional on non-strategic behaviour by the the policy maker in this country. However, if both upstream governments act strategically, and non-cooperatively, the result is reversed, although increased competition in *both* exporting countries might benefit these countries in some special cases.

Increased downstream competition, on the other hand, is shown always to benefit the importing country. However, contrary to the case

[11] In a model with oligopolist firms in a single exporting country selling directly to consumers in an importing country, and with an export tax and an import tariff as the policy instruments, the equivalent result is shown to hold if demand is not too convex.

of free trade, *upstream* welfare might suffer. For example, if the good is supplied from firms in two exporting countries, increased downstream competition beyond a quite concentrated level reduces upstream welfare. Thus, in the context of our natural gas example, even if the major non-EU gas producers like Norway and Russia retain control over their domestic competition policies, liberalisation of the downstream European gas market may affect these exporting countries negatively.

To the best of our knowledge, ours is the only paper that studies policy competition between exporting and importing countries in successive international oligopoly. Our analysis relates closely to several strands of the international trade literature, though. The idea of using some form of domestic taxation to extract rents from foreign exporters with market power was first presented by Katrak (1979), and has since been elaborated on and extended in numerous papers.[12] However, a common feature in these papers is a lack of foreign policy response.[13]

Our paper also relates to a more recent body of contributions that explicitly models a vertical industry structure with trade in intermediates within a context of strategic trade policy.[14] However, these analyses focus either on final-goods competition in a third market – á la Brander and Spencer (1985) – or on domestic trade policy only, which makes them quite different from our study.[15]

[12] See, e.g., Brander and Spencer (1981, 1984), Bergstrom (1982), Brander and Djajic (1983), Hillman and Templeman (1985) and Lahiri and Ono (1999). Raimondos-Møller and Woodland (2000) derive similar results in a perfectly competitive context, but where the trade policy game is characterised by a sequential structure.

[13] An important exception is Brander and Spencer (1984), who include foreign policy in an analysis of optimal domestic tariff policy for extracting rents from a foreign oligopoly. However, the foreign policy instrument is taken to be the degree of 'cartelisation' only, with the implication that complete cartelisation is the optimal policy when foreign consumption of the good is negligible. However, by equipping the foreign government with the power also to tax, the exact opposite conclusion is reached.

[14] See, e.g., Spencer and Jones (1991, 1992), Ziss (1997), Bernhofen (1997), Ishikawa and Lee (1997), Ishikawa and Spencer (1999) and Chang and Sugeta (2004).

[15] Of the aformentioned papers, Ishikawa and Lee (1997) and Ishikawa and Spencer (1999) are perhaps the most closely related, in the sense that they consider a successive Cournot oligopoly similar to ours. However, besides the fact that these papers consider domestic trade policy only, there is a marked difference from the present paper in the types of international market structures that are analysed.

Finally, the present paper makes a contribution to the literature on the interplay between competition and trade policy. Much of this research focus on the substitutability of strategic trade and merger policies, and the question of whether trade liberalisation will induce laxer competition policies.[16] We complement this literature by analysing the interaction of different policy incentives in vertically linked industries. A novel finding is that strategic use of tax policies may increase the conflict of interest, with respect to competition policies, between exporting and importing countries.

2 The basic model

Consider an industry with two vertically related activities in two different countries. There are m independent (and identical) upstream producers of a homogenous good in country U supplying n independent (and identical) downstream distributors in country D, where the good is consumed.[17] We want to portray a situation where downstream firms are dependent on key inputs from upstream suppliers in one or a few countries, where domestic consumption (in the exporting countries) is typically negligible, compared with the export volumes. Thus, to simplify and keep the analysis clearly focused, we assume that there is no consumption of the good in the exporting country.[18]

The firms compete à la Cournot at both stages of the value-chain. In line with the received literature on successive Cournot oligopoly, we assume that each downstream firm takes the wholesale price (as well as the outputs of other downstream firms) as given when committing to an output quantity. As noted by Salinger (1988) and others, this amounts to giving upstream producers a first-mover advantage.

[16] In addition to the aforementioned paper by Cowan, important contributions include Auquier and Caves (1979), Dixit (1984), Richardson (1999), Horn and Levinsohn (2001), Huck and Konrad (2004), De Stefano and Rysman (2004) and Saggi and Yildiz (2004).

[17] Alternatively, we can think of the upstream activity as the production of a homogenous intermediate good which is transformed into a homogenous final good by downstream firms at constant marginal costs.

[18] In the context of the European natural gas market, this is actually a quite accurate assumption for one of the largest gas producers, Norway, where domestic consumption of natural gas is practically non-existent.

Within this context, a role for strategic trade policy is created by letting the governments in both countries use taxes (or subsidies) strategically, in order to shift rents up or downwards in the value-chain. We consider the following three-stage game:

Stage 1: the governments in U and D simultaneously and independently commit to their preferred values of upstream and downstream taxes (subsidies), respectively.

Stage 2: the upstream firms simultaneously and independently commit to the quantities supplied to the downstream market.

Stage 3: the downstream firms simultaneously and independently commit to the quantities supplied to the final consumers.

3 Market equilibrium

As usual, the game is solved by backwards induction.

Downstream

The market-clearing retail price is given by

$$p = a - Q, \tag{1}$$

where $Q := \sum_{i=1}^{n} q_i$ is the total output supplied by downstream distributors. Denoting the wholesale price by w, the profit function of a downstream firm i is given by

$$\pi_i^D = \left(p - w - t^D\right) q_i, \tag{2}$$

where t^D is a tax rate set by the government in country D. In the Cournot-Nash equilibrium, the output of each downstream firm is

$$q_i = \frac{a - w - t^D}{n+1}, \quad i = 1, ..., n. \tag{3}$$

Upstream

Aggregating (3) and rearranging, we can derive the inverse demand function facing the upstream firms. This is defined as

$$w = a - t^D - \left(\frac{n+1}{n}\right) X, \tag{4}$$

where $X := \sum_{j=1}^{m} x_j$ is total output supplied by the upstream firms. Assuming constant marginal costs of production, c, profits for an upstream firm j are given by

$$\pi_j^U = \left(w - t^U\right) x_j - c x_j, \tag{5}$$

where t^U is a tax rate set by the government in country U.[19]

In the Cournot-Nash equilibrium, the output of each upstream firm is

$$x_j = \frac{n\left(a - c - t^D - t^U\right)}{(m+1)(n+1)}, \quad j = 1, ..., m. \tag{6}$$

This yields an equilibrium total supply of

$$X = Q = \frac{mn\left(a - c - t^D - t^U\right)}{(m+1)(n+1)}, \tag{7}$$

and equilibrium wholesale and retail prices given by, respectively,

$$w = \frac{\left(a - t^D + m\left(c + t^U\right)\right)}{(m+1)} \tag{8}$$

and

$$p = \frac{(m+n+1)\, a + mn\left(c + t^D + t^U\right)}{(m+1)(n+1)}. \tag{9}$$

Note that the structural richness of the model allows for different standard assumptions to appear as special cases. For example, $m \to \infty$ implies that downstream firms source their inputs from a perfectly competitive upstream market. In this case, the input (or wholesale) price is simply given by $w = c + t^U$. On the other hand, $n \to \infty$ implies that $p = w + t^D$. In this case, our model is equivalent to a standard

[19] To ensure a positive supply of the good in equilibrium, we must require that $c < a$.

trade model with foreign exporters selling directly to consumers in the importing country, where t^D corresponds to an import tariff.

3.1 Taxation and rent-shifting

Before solving for the policy equilibrium, it is instructive, though fairly standard, to consider how taxation can be used to shift rents between different parts of the vertical value-chain. The effects of taxation on prices and output follow straightforwardly from (7)-(9). A higher downstream tax will induce downstream firms to reduce their outputs, which causes an increase in the final price, p. However, such a tax increase also spills over into the upstream part of the industry. A downstream output contraction implies that the demand curve facing the upstream producers shifts inward, causing the equilibrium wholesale price to decrease. Similarly, a higher upstream tax leads to a reduction of upstream output, but part of such a tax increase spills over into the downstream country through a higher wholesale price, causing also the retail price to increase.

In effect, downstream taxes are partly paid by upstream firms, whereas upstream taxes are partly paid by downstream firms and consumers. Conversely, a downstream *subsidy* will partly benefit upstream firms, and vice versa. An increase in either upstream or downstream taxes will consequently reduce total output (and thus consumers' surplus) and profits of both upstream and downstream firms. This is confirmed by deriving the expressions for equilibrium profits. For given tax rates, these are given by

$$\pi_j^U = \frac{n\left(a-c-t^D-t^U\right)^2}{(m+1)^2(n+1)}, \quad j=1,...,m, \tag{10}$$

and

$$\pi_i^D = \frac{m^2\left(a-c-t^D-t^U\right)^2}{(m+1)^2(n+1)^2}, \quad i=1,...,n. \tag{11}$$

4 Policy equilibrium

We make the standard assumption that national policy makers maximise national welfare, defined as the total surplus accruing to all agents situated in a given country. The objective functions of the governments in U and D, respectively, are then given by

$$W^U = \sum_{j=1}^{m} \left(\pi_j^U + t^U x_j \right) \tag{12}$$

and

$$W^D = CS + \sum_{i=1}^{n} \left(\pi_i^D + t^D q_i \right), \tag{13}$$

where $CS = \frac{1}{2}Q^2$ is consumers' surplus.[20]

The first-order conditions from the simultaneous maximisation problem define two best-response functions in the policy game,[21]

$$t^U \left(t^D \right) = \frac{(m-1)\left(a - c - t^D \right)}{2m} \tag{14}$$

and

$$t^D \left(t^U \right) = \frac{(n+1-m)\left(a - c - t^U \right)}{2(n+1) + mn}, \tag{15}$$

From (14) it is clear that in the case of an upstream monopoly ($m = 1$), the optimal upstream tax rate is zero, irrespective of the downstream tax policy. Otherwise, the equilibrium value of t^U is positive. This reflects the terms-of-trade motive for upstream taxation.[22] When there are more than one upstream firm, private incentives lead to socially excessive output, from the viewpoint of upstream welfare, and the government can induce outcomes closer to the cartel output by taxing upstream production (or exports). We also see that $\partial t^U / \partial t^D < 0$ for $m > 1$. A lower downstream tax rate will reduce the wholesale price

[20] Since we allow for negative tax rates, this definition of welfare relies on an implicit assumption that the governments are able to raise funds for subsidy payments in a non-distortionary manner.

[21] The second-order conditions are satisfied for all possible parameter configurations, ensuring that $t^U + t^D < a - c$ in equilibrium.

[22] See also Dixit (1984) and Eaton and Grossman (1986).

and trigger an upstream output expansion. Once more, though, each upstream firm imposes a negative externality on the other firms when expanding their output, causing an excessive response to the downstream tax reduction. Thus, the optimal upstream policy response is a tax increase.

The policy maker in the downstream country, on the other hand, must balance two different considerations when framing the optimal policy. On the one hand, the government can extract some upstream rents by imposing a positive downstream tax rate. On the other hand, considerations for efficiency dictate that the government should use a subsidy to stimulate downstream competition, thereby increasing consumers' surplus.

The *rent-extraction* effect depends on the ability of the downstream government to affect the wholesale price, which, in turn, requires a certain degree of upstream market power. Increased competition in the upstream part of the industry makes the wholesale price less sensitive to changes in the downstream tax rate, which weakens the rent-extraction motive for downstream trade policy.[23] The *efficiency* motive, on the other hand, is also determined by the degree of *downstream* competition. The lower the number of firms operating in the downstream market, the stronger the incentives to reduce taxes (or increase subsidies) in order to stimulate competition. Thus, the optimal balancing of the *rent-extraction* and *efficiency* motives depends on the relative number of upstream and downstream firms. From (15) we see that the rent-extraction motive dominates if $n+1 > m$, implying $t^D > 0$, whereas the opposite is true for $n+1 < m$. In the former case, we also observe that upstream and downstream tax rates are strategic substitutes.

Simultaneously solving (14) and (15) yields the equilibrium expressions for optimal tax rates,

$$t^U = \frac{(m-1)(n+1)(a-c)}{m+n+2mn+1}, \tag{16}$$

[23] From (8) we have that $\partial w/\partial t^D = -1/(m+1)$.

$$t^D = \frac{(1+n-m)(a-c)}{m+n+2mn+1}. \tag{17}$$

We summarise the characterisation of the policy equilibrium as follows:[24]

Proposition 1 *(i) The equilibrium upstream tax rate is zero if* $m = 1$*, and positive otherwise. (ii) The equilibrium downstream tax rate is positive (negative) if* $n + 1 > (<)\, m$*.*

Furthermore, the comparative statics result for the equilibrium tax rates are easily derived from (16)-(17):

Proposition 2 *(i)* $\partial t^U/\partial n < (=)\, 0$ *if* $m > (=)\, 1$*,*
(ii) $\partial t^U/\partial m > 0$*,*
(iii) $\partial t^D/\partial n > 0$*,*
(iv) $\partial t^D/\partial m < 0$*.*

The intuition for *(ii)-(iv)* follows directly from the above discussion. Regarding *(i)*, the decrease in the upstream tax rate due to increased downstream competition (for $m > 1$) is a strategic response to the increase in downstream taxes when the efficiency motive for downstream taxation is weakened.

5 Industry concentration and national welfare

How does increased competition in the upstream or downstream part of the industry affect national welfare when national policy makers act strategically with respect to their tax policies? Before looking more closely into this question, let us first consider the laissez-faire policy as a benchmark case. With $t^U = t^D = 0$, equilibrium expressions for national welfare are given by

$$W_{LF}^U = \frac{mn(a-c)^2}{(m+1)^2(n+1)} \tag{18}$$

and

$$W_{LF}^D = \frac{m^2 n(n+2)(a-c)^2}{2(m+1)^2(n+1)^2}, \tag{19}$$

[24] The formal proofs of all Propositions throughout the paper are based on straightforward algebra and are thus not reported.

from which it follows that[25]

$$\frac{\partial W_{LF}^{U}}{\partial m} < 0, \quad \frac{\partial W_{LF}^{D}}{\partial m} > 0, \quad \frac{\partial W_{LF}^{U}}{\partial n} > 0, \quad \frac{\partial W_{LF}^{D}}{\partial n} > 0.$$

Increased *upstream* competition reduces upstream profits and benefits downstream firms (through a lower wholesale price) and consumers (trough a lower retail price). Increased *downstream* competition, on the other hand, benefits both countries, in terms of national welfare. Upstream firms benefit due to increased demand from the downstream market. Downstream profits suffer, but this is more than outweighed by an increase in consumers' surplus.

Things change, though, if national policy makers use tax instruments strategically. Applying (16)-(17), the equilibrium expressions for national welfare in the policy game are given by

$$W^{U} = \frac{m^2 n \left(1+n\right) \left(a-c\right)^2}{\left(m+n+2mn+1\right)^2}, \tag{20}$$

$$W^{D} = \frac{mn \left(2\left(n+1\right)+mn\right) \left(a-c\right)^2}{2\left(m+n+2mn+1\right)^2}, \tag{21}$$

from which we can derive the following result:

Proposition 3 *(i) Increased upstream competition increases upstream welfare and reduces downstream welfare, whereas (ii) increased downstream competition increases both upstream and downstream welfare.*

The introduction of strategic trade policy leads to a surprising result with respect to industry concentration in the upstream part of the industry.[26] Contrary to the benchmark case, increased upstream competition actually benefits the upstream country and harms the downstream country, in terms of social welfare. If we decompose the effect of an increase in m, we find that upstream firms lose, while downstream firms and

[25] Technically, $\partial W_{LF}^{U}/\partial m = (<)\, 0$ if $m = (>)\, 1$. However, the integer restriction on m means that welfare is reduced when increasing the number of upstream firms from 1 to 2.

[26] As mentioned in the Introduction, this result mirrors Cowan (1989), who considers a model that is equivalent to $n \to \infty$ in our model.

consumers benefit, as in the benchmark case. What happens, though, is that *tax revenues are shifted upstream*.

The intuition is related to the optimal tax responses to an increase in upstream competition. An increase in the number of upstream suppliers leads to increased upstream taxes, while downstream taxes are reduced. As argued in the previous Section, an increase in m reduces the rent-extraction motive for the downstream government, leading to a lower downstream tax rate. Although total output increases, the possibility of shifting rents downstream is reduced, and downstream welfare drops as a consequence. Upstream welfare increases for the same reason. Increased upstream competition means that less rents are shifted downwards in the value-chain, while the upstream government optimally increases the tax rate to correct for the negative competition externality.

This result is in sharp contrast to the notion that complete cartelisation is always beneficiary for an exporting country with no domestic consumption of the good.[27] The reason is simply that cartelisation has two opposing effects on upstream welfare. On the one hand, it reduces (or eliminates) the negative competition externality, which is the intended effect. On the other hand, though, it increases the amount of rents available for extraction by downstream policy makers. To the extent that m is a choice variable, it is better for the upstream government to increase m – thereby reducing the scope for rent-extraction – and instead use the tax instrument to indirectly regulate the upstream oligopoly. An increase in m is optimally accompanied by an increase in t^U, which triggers a reduction in t^D. We can think of this as the domestic, rather than a foreign, government taxing away the domestic rents.

The welfare effects of increased downstream competition, on the other hand, are qualitatively the same as in the benchmark case. All else equal, increased downstream competition spurs demand from the downstream market, which benefits upstream firms. However, an increase in n also reduces the efficiency motive for downstream taxation, implying that t^D goes up, which reduces the wholesale price. The upstream policy maker optimally responds by reducing t^U. Nevertheless,

[27] See, e.g., Brander and Spencer (1984).

only downstream profits suffer from an increase in downstream competition. Upstream profits, consumers' surplus and tax revenues in both countries increase.

6 International upstream oligopoly

In this section we extend our analysis to consider the case where upstream suppliers are located in different countries, which opens up for additional policy incentives. For an upstream country, a potential adverse effect of increasing taxes is a loss of market share to foreign upstream competitors, which may reduce or eliminate the positive effect of increased upstream competition, as reported in Proposition 3.

In the following, we make the assumption that upstream suppliers – which are identical in all respects but location – are located in two different countries, where m_1 and m_2 are the number of firms in countries U1 and U2, respectively. The corresponding tax rates are denoted t_1^U and t_2^U. We will intermittently refer to U1 and U2 as the 'domestic' and 'foreign' upstream countries, respectively, and our focus is directed towards the domestic part of the upstream market. We start out by considering the case where the foreign government (in country U2) does not act strategically, and set $t_2^U = 0$. Afterwards, we include both upstream governments in the policy game.

6.1 Market equilibrium

In the Cournot-Nash equilibrium, outputs by upstream firms in U1 and U2, denoted by x and y, respectively, are given by

$$x_j = \frac{n\left[a - c - t^D - t_1^U + m_2\left(t_2^U - t_1^U\right)\right]}{\left(m_1 + m_2 + 1\right)\left(n + 1\right)}, \quad j = 1, ..., m_1, \tag{22}$$

$$y_k = \frac{n\left[a - c - t^D - t_2^U + m_1\left(t_1^U - t_2^U\right)\right]}{\left(m_1 + m_2 + 1\right)\left(n + 1\right)}, \quad k = 1, ..., m_2. \tag{23}$$

Total quantity supplied in equilibrium is given by

$$X = Q = \frac{n\left[\left(m_1 + m_2\right)\left(a - c - t^D\right) - m_1 t_1^U - m_2 t_2^U\right]}{\left(m_1 + m_2 + 1\right)\left(n + 1\right)}, \tag{24}$$

with corresponding wholesale and retail equilibrium prices given by

$$w = \frac{a - t^D + (m_1 + m_2)\, c + m_1 t_1^U + m_2 t_2^U}{(m_1 + m_2 + 1)} \tag{25}$$

and

$$p = \frac{(n+1)\, a + (m_1 + m_2)\left[a + n\left(c + t^D\right)\right] + n\left(m_1 t_1^U + m_2 t_2^U\right)}{(m_1 + m_2 + 1)\,(n+1)}. \tag{26}$$

6.2 Non-strategic behaviour by the foreign upstream government

The policy game is similar to the one outlined in Section 4, except that the policy makers in U1 and D now take into consideration how their policy choices will affect the strategic behaviour of upstream suppliers in U2. Setting $t_2^U = 0$, the first order-conditions from the simultaneous maximisation problem define the following best-response functions:

$$t_1^U\left(t^D\right) = \frac{(m_1 - m_2 - 1)\left(a - c - t^D\right)}{2m_1\,(m_2 + 1)}, \tag{27}$$

$$t^D\left(t_1^U\right) = \frac{\left[(m_1 + m_2)\,(a - c) - m_1 t_1^U\right]\left[n + 1 - (m_1 + m_2)\right]}{(m_1 + m_2)\left[2\,(n+1) + n\,(m_1 + m_2)\right]}. \tag{28}$$

Foreign upstream competition introduces a new dimension to the optimal choice of t_1^U, implying that the government in U1 must balance two opposing considerations. In addition to the previous *terms-of-trade* motive for taxation, there is now a *rent-shifting* motive vis-á-vis the foreign competitors. By subsidising production (or exports), the government in U1 can induce the domestic firms to increase output. Since the firms' choice variables are strategic substitutes, such a policy will shift rents from foreign to domestic upstream firms.[28] This effect obviously puts a downward pressure on the upstream tax rate. The optimal balancing of the two motives for upstream taxation depends on the relative number of firms in U1 and U2. From (27) we see that the terms-of-trade motive

[28] This is just the 'classic' strategic trade policy argument from Brander and Spencer (1985).

dominates – implying a positive tax rate – if $m_1 > m_2 + 1$.

Whether or not the optimal *downstream* policy implies a positive tax rate, on the other hand, is only dependent on the total number of foreign suppliers, relative to the number of downstream distributors. The downstream government faces the same trade-off between rent-extraction and market efficiency as before, and the optimal downstream tax rate is positive if $n + 1 > m_1 + m_2$.

Simultaneously solving (27) and (28) yields

$$t_1^U = \frac{(m_1 + m_2)(m_1 - m_2 - 1)(n + 1)(a - c)}{m_1 (m_1 + n + 3m_2 + 2m_1 n + 4m_2 n + 2m_1 m_2 n + 2m_2^2 n + 1)}, \tag{29}$$

$$t^D = \frac{(2m_2 + 1)[n + 1 - (m_1 + m_2)](a - c)}{m_1 + n + 3m_2 + 2m_1 n + 4m_2 n + 2m_1 m_2 n + 2m_2^2 n + 1}. \tag{30}$$

Summarising the above analysis, the policy equilibrium is characterised as follows:

Proposition 4 *With non-strategic behaviour by the foreign upstream government,*

(i) $t_1^U > (<) 0$ *if* $m_1 > (<) m_2 + 1$,

(ii) $t^D > (<) 0$ *if* $n + 1 > (<) m_1 + m_2$.

It is also straightforward to verify – by comparing (16) and (29) – that the presence of 'foreign' upstream suppliers reduces the optimal upstream tax rate for all values of m_2, due to the export market rivalry between the exporting countries.

From (29)-(30) we can also derive the comparative statics result for the equilibrium tax rates:

Proposition 5 *With non-strategic behaviour by the foreign upstream government,*

(i) $\partial t_1^U / \partial n < (>) 0$ *if* $m_1 > (<) m_2 + 1$,

(ii) $\partial t_1^U / \partial m_1 > 0$,

(iii) $\partial t^D / \partial n > 0$,

(iv) $\partial t^D / \partial m_1 < 0$.

The intuition for *(ii)-(iv)* follows from previous analysis and discussion. The new feature introduced by foreign upstream competition is that the equilibrium upstream tax rate can now be an increasing function of n. This is the case if $m_1 < m_2 + 1$, which implies that the equilibrium upstream tax rate is negative. Once more, this is a strategic response to changes in the downstream tax rate. When $t_1^U < 0$, export market rivalry is the dominant force in determining domestic upstream tax policy. An increase in downstream competition implies an increase of the downstream tax rate, which reduces the wholesale price, and thereby the profitability of supplying the export market. This reduces the incentives for using upstream subsidies to capture downstream market shares, and the optimal upstream subsidy in U1 is correspondingly reduced.

Industry concentration and welfare

Since upstream competition between different exporting countries puts a downward pressure on upstream taxes, one might conjecture that the positive relationship between upstream competition and welfare – as reported in Proposition 3 – will be reversed, since this result relies on the upstream government's ability to increase taxation as a response to increased upstream competition.

Using (29)-(30), equilibrium expressions for social welfare in U1 and D are given by

$$W_1^U = \frac{(m_1+m_2)^2 (m_2+1)(n+1) n (a-c)^2}{(m_1+n+3m_2+2m_1n+4m_2n+2m_1m_2n+2m_2^2n+1)^2} \quad (31)$$

and

$$W^D = \frac{(m_1+m_2)(2m_2+1)^2 [2(n+1)+(m_1+m_2)n] n (a-c)^2}{2(m_1+n+3m_2+2m_1n+4m_2n+2m_1m_2n+2m_2^2n+1)^2}. \quad (32)$$

From (31)-(32) we can easily derive the welfare effects of increased competition:

Proposition 6 *With non-strategic behaviour by the foreign upstream government,*

(i) $\partial W_1^U/\partial m_1 > 0$,
(ii) $\partial W^D/\partial m_1 < 0$,
(iii) $\partial W_1^U/\partial n > (<)\, 0$ *if* $n < (>)\, \overline{n} := \frac{m_1+3m_2+1}{2m_2(m_1+m_2-1)-1}$,
(iv) $\partial W^D/\partial n > 0$.

Parts *(i)-(ii)* of the Proposition confirms that the presence of foreign upstream suppliers does *not* qualitatively change the welfare effects of increased upstream competition that were derived in the previous Section. As before, increased competition in the domestic upstream market leads to higher taxes upstream and lower downstream, with the resulting effect that tax revenues are shifted up the value-chain. Even though foreign upstream competition puts a downward pressure on upstream taxes, the lack of policy response (by assumption) from the foreign exporting country ensures that the positive (negative) correspondence between upstream competition and upstream (downstream) welfare remains.

However, increased *downstream* competition might now harm *upstream* welfare. From part *(iii)* of the Proposition, we see that this is the case if the number of downstream firms is above a critical level $\overline{n} \leq 5$.[29] This is due to the policy response of the government in the importing country.[30] Higher downstream competition has two opposing effects on upstream welfare: it increases demand from the downstream market, which benefits upstream firms, but it also induces a downstream tax increase, which has the opposite effect. The total effect on upstream welfare depends thus on the relative strength of these two effects. If the domestic exporting country is the single supplier of the good to the downstream market, we have demonstrated that the first effect always dominates. However, competition from a second exporting country puts a downward pressure on upstream taxes, which increases upstream

[29] Since $\overline{n}$ is monotonically increasing in m_1 and m_2, it follows that $\overline{n} \leq 5$ for all permissible values of m_1 and m_2.

[30] It can easily be shown that, with non-strategic behaviour by the downstream government, increased downstream competition will always benefit the exporting countries.

rents and thus the incentive for rent-extracting taxation in the importing country.[31] Consequently, the downstream tax response to increased competition in the downstream market is *stronger* when the good is supplied from two exporting countries. If n gets sufficiently large, this is enough make the overall effect on upstream welfare negative.

6.3 Strategic behaviour by both upstream governments

Let us now consider the case where also the foreign upstream government acts strategically, and chooses t_2^U to maximise the total surplus accruing to country U2. In this case, the model boils down to a standard third-market model of strategic trade policy, with the added features of downstream firms and an active government in the 'third market'.

The first-order conditions of the policy game define the best response functions for optimal upstream taxes:

$$t_1^U\left(t_2^U, t^D\right) = \frac{\left(m_1 - m_2 - 1\right)\left(a - c - t^D + m_2 t_2^U\right)}{2m_1\left(m_2 + 1\right)}, \tag{33}$$

$$t_2^U\left(t_1^U, t^D\right) = \frac{\left(m_2 - m_1 - 1\right)\left(a - c - t^D + m_1 t_1^U\right)}{2m_2\left(m_1 + 1\right)}, \tag{34}$$

which illustrate that the aforementioned trade-off between the *terms-of-trade* and the *rent-shifting* motives for upstream taxation now applies equally to both upstream countries. Once more, the optimal balancing of these two considerations is determined by the relative number of firms in the two countries. The best-response functions reveal that *positive upstream taxes in both countries cannot be part of any policy equilibrium.* With an equal number of firms in both countries, the rent-shifting motive always dominates, implying that the optimal upstream policies entail subsidies. An increase in the number of firms in one of the upstream countries will strengthen the terms-of-trade motive in this country, but increase the rent-shifting incentive in the other country, implying that positive taxes in both countries cannot be an equilibrium.

[31] This can be seen directly from the best-response function of the downstream policy maker, (28).

The best-response function for the downstream policy maker,

$$t^D\left(t_1^U, t_2^U\right) = \frac{(1+n-(m_1+m_2))\left[(m_1+m_2)(a-c)-m_1t_1-m_2t_2\right]}{(m_1+m_2)\left[2(n+1)+(m_1+m_2)n\right]}, \tag{35}$$

reveal that the trade-off between rent-extraction and market efficiency is similar to the previous versions of the model, with the exact same condition for a positive downstream tax rate as before.

Simultaneously solving (33)-(35) yields the equilibrium tax rates

$$t_i^U = \frac{(m_i+m_j)(m_i-m_j-1)(n+1)(a-c)}{m_i\left(2(n+1)+(m_i+m_j)\left[2(2n+1)+(m_i+m_j)n\right]\right)}, \tag{36}$$

$i, j = 1, 2, \quad i \neq j$, and

$$t^D = \frac{(m_1+m_2+2)\left[1+n-(m_1+m_2)\right](a-c)}{2(n+1)+(m_1+m_2)\left[2(2n+1)+(m_1+m_2)n\right]}. \tag{37}$$

The above discussion is summarised by the following characterisation of the policy equilibrium:

Proposition 7 *(i) If $m_i = m_j$, then $t_i^U = t_j^U < 0$.*
(ii) If $m_i = m_j + 1$, then $t_j^U < t_i^U = 0$.
(iii) If $m_i > m_j + 1$, then $t_j^U < 0 < t_i^U$.

Once more, the comparative statics results with respect to equilibrium taxes are easily derived from (36)-(37):

Proposition 8 *(i) $\partial t_i^U/\partial m_i > (<)\, 0$ if $m_i < (>)\, \overline{m}$, where $\overline{m} > m_j + 1$,*
(ii) $\partial t_j^U/\partial m_i < 0$,
(iii) $\partial t^D/\partial m_i < 0$,
(iv) $\partial t_i^U/\partial n < (>)\, 0$ if $m_i > (<)\, m_j + 1$,
(v) $\partial t^D/\partial n > 0$.

Compared with the previous versions of the model, the new results regard the upstream tax responses to increased upstream competition. Starting from a monopoly situation in country i ($m_i = 1$), increased competition will induce the government in this country to increase taxes, as

before. However, if m_i gets very large the upstream tax rate will eventually start converging to zero from above. With a perfectly competitive upstream market in country i (i.e., $m_i \to \infty$), the equilibrium wholesale price is given by $w = c + t_i^U$. Consequently, a positive tax rate in country i would drive the firms in this country out of business.

The most important new result is stated in part *(ii)* of the Proposition, though, which shows that increased competition in an upstream country will always provoke a tax reduction from the competing upstream country. The more competitive the upstream market in country i is, the more effective is the use of tax instruments by the rivaling country j to influence the equilibrium share of the export market served by this country.[32] In other words, the higher is m_i relative to m_j, the stronger is the *rent-shifting* motive, relative to the *terms-of-trade* motive, for taxation in country j. Thus, the optimal policy response from country j to an increase in m_i, is to improve the domestic firms' competitive position in the export market by reducing the tax rate, t_j^U. This result has important implications for the welfare effects of increased upstream competition, as we will se below.

Industry concentration and welfare

Explicit expressions for social welfare in the policy equilibrium are given by

$$W_i^U = \frac{(m_i + m_j)^2 (m_j + 1)(n + 1) n (a - c)^2}{(2(n + 1) + (m_i + m_j)[2(2n + 1) + (m_i + m_j) n])^2}, \qquad (38)$$

$i, j = 1, 2, \quad i \neq j$, and

$$W^D = \frac{(m_i + m_j + 2)^2 (m_i + m_j)[2(n + 1) + (m_i + m_j) n] n (a - c)^2}{2(2(n + 1) + (m_i + m_j)[2(2n + 1) + (m_i + m_j) n])^2}. \qquad (39)$$

The relationship between industry concentration and welfare in the different parts of the vertical industry is outlined in the final Proposition of the paper:

[32] This is easily confirmed by using (22)-(23) to calculate how tax reductions influence relative market shares in equilibrium.

Proposition 9 *(i)* $\partial W_i^U/\partial m_i < 0$,
(ii) $\partial W_j^U/\partial m_i > (<)\, 0$ *if* $m_i > (<)\, \widehat{m}$, *where* $\widehat{m} < m_j$.
(iii) $\partial W^D/\partial m_i > 0$,
(iv) $\partial W_i^U/\partial n > (<)\, 0$ *if* $n < (>)\, \widehat{n} := \frac{2(m_1+m_2+1)}{(m_1+m_2)^2-2}$,
(v) $\partial W^D/\partial n > 0$.

From part *(i)* of the Proposition we see that the previous relationship between competition and welfare in the upstream market is now reversed. This is due to the policy competition between the exporting countries, and closely related to part *(ii)* of Proposition 8. When the governments in both exporting countries act strategically, increased upstream competition in country i triggers a tax reduction in the competing upstream country, with a subsequent reduction in export market shares, and thus welfare, in country i.

However, increased competition in one exporting country might increase welfare in the *other* exporting country, as part (ii) of the Proposition suggests.[33] This raises the question of whether the previously derived positive relationship between upstream competition and welfare might be restored – even in the case of policy competition between rivaling exporting countries – if we consider a *simultaneous liberalisation of both upstream markets*. From (38), we can easily derive

$$\frac{\partial W_i^U}{\partial m_i} + \frac{\partial W_i^U}{\partial m_j} = \frac{\Phi\,(m_i+m_j)\,(n+1)\,n\,(a-c)^2}{(2\,(n+1)+(m_i+m_j)\,[2\,(2n+1)+n\,(m_i+m_j)])^3},$$

where

$$\Phi = 2\,(4+m_i+5m_j)\,(n+1)+(m_i+m_j)^2\,[2+n\,(m_i-3m_j)]\,.$$

[33] From (38) we have that

$$\frac{\partial W_i^U}{\partial m_j} = \frac{(a-c)^2\,(n+1)\,n\,(m_i+m_j)\left[\Psi+n\,(m_i-m_j)\,(m_i+m_j)^2\right]}{(2\,(n+1)+(m_i+m_j)\,(2\,(2n+1)+n\,(m_i+m_j)))^3},$$

where

$$\Psi := 2\left(2+m_i+3m_j+(m_i+m_j)^2\right)(n+1) > 0.$$

We see that $m_i \geq m_j$ is a sufficient (but not necessary) condition for $\partial W_i^U/\partial m_j > 0$.

An exporting country will lose from increased competition in its own country, but gain from increased competition in the rivaling upstream country. The net gain is determined by the sign of Φ, which is ambiguous. In general, we see that country i will always benefit from increased competition in both upstream markets if m_i is, and remains, sufficiently larger than m_j, which suggests that only one country – if any at all – will stand to gain. This is also generally the case, although numerical simulations suggest that both countries might benefit if the degree of concentration is, and remains, at a very high level.[34]

Finally, we can observe – from part *(iv)* of Proposition 9 – that the potential for exporting countries being adversely affected by a more competitive downstream market is reinforced, compared with the analysis in Section 6.2. Now, increased downstream competition will hurt exporting countries if the number of downstream firms is larger than $\widehat{n} \leq 3$. Strategic trade policy by both exporting countries puts an additional downward pressure on upstream taxes, which reinforces the incentive for rent-extracting taxation in the importing country, implying that the downstream tax response to increased downstream competition is even stronger than in the previous cases. This consequently increases the likelihood that a more competitive downstream market will hurt the exporting countries.

7 Concluding remarks

In this paper we have presented a comprehensive analysis of tax policy competition between exporting and importing countries in vertically linked industries, using a model of successive international Cournot oligopoly, with a particular emphasis on how the degree of concentration in the different parts of the industry affects the distribution of rents among the countries. Here we will not recapitulate all results of the paper, but rather provide some final thoughts and elaborations on a

[34]For the special case of $m_1 = m_2$, numerical simulations seem to confirm that going from one to two firms in each exporting country increases welfare in both, whereas an increase from two to three is only beneficial if there is a downstream monopoly ($n = 1$). An increase in the number of firms beoynd three in each country is not beneficial for any of the exporting countries.

couple of our main findings regarding the welfare effects of increased competition in the industry.

Elaborating on and extending a similar result in the previous literature, we have shown that a more competitive upstream market can benefit an exporting (upstream) country, while hurting the importing (downstream) country. In our model, this result holds even in the case of supply from a second exporting country, providing that the government in this country acts non-strategically. When both upstream governments engage in strategic trade policy, though, the result is generally reversed, although increased competition in *both* upstream countries *might* benefit both exporting countries in a few special cases. If the exporting countries were able perfectly to *collude* on their tax policies, though, we would effectually be back in the equilibrium of the basic model, with supply from a single exporting country. This has some interesting implications with respect to, for example, the optimal strategy of an international cartel like OPEC. To the extent that a tax response from importing countries can be spurred, it might be more important (i.e., profitable) for the OPEC countries to coordinate their *tax policies*, rather than their export volumes.

We also find that a more competitive downstream industry may in fact hurt exporting countries when policy makers act strategically. In our particular model, in the case of strategic behaviour by all involved countries, this will be always happen whenever the number of domestic firms exceeds three. This result suggests that the use of strategic trade policy is likely to increase the conflict of interest, with respect to competition policies, between exporting and importing countries. In the case referred to above, the conflict of interest is close to complete: the importing country would like to stimulate competition in all parts of the industry, whereas the exporting countries have generally the exact opposite interests.

Finally, we should emphasise that, in order to increase the richness of our analysis, relative to the received literature, generality of functional forms has to a certain extent been sacrificed to the benefit of higher structural generality. Thus, we cannot claim a high degree of generality

for all of our results. We do, however, believe that the main mechanisms at work apply to a wider class of demand and cost functions than the linear specifications. Besides, in the cases where opposing forces produce ambiguous results, these will obviously persist under more general demand and cost assumptions.

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