Export Subsidies and Countervailing Duties Under Asymmetric Information

Matloob Piracha
Department of Economics
University of Kent

Abstract

This paper explores the role of information in the formulation of trade policy for home and foreign country, in a setting in which the home government chooses its subsidy level first after which the foreign firm retaliates by imposing tariffs on its imports. We consider an environment in which home firm costs are private information but it can signal these costs to both policymakers and the foreign firm by choosing the appropriate output level. We show that a low-cost home firm has an incentive to misrepresent itself as high-cost. This is understood by the foreign firm and both policymakers and results in the home government setting a higher subsidy in the signalling case compared to the case when the home firm's output was not a signal of its costs; the foreign government sets the same tariff in both cases.

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Address for Correspondence: Matloob Piracha, Department of Economics, University of Kent, Canterbury, Kent CT2 7NP. Tel: +44 (0)1227 827029; fax: +44 (0) 1227 827450; email: M.E.Piracha@kent.ac.uk

1. Introduction

Export subsidies are used in oligopolistic industries to shift rents from foreign firms to the domestic firms, which increases domestic country's welfare as shown by Brander and Spencer (1985). An export subsidy may result in lower prices in the importing country which enhances consumer surplus but the industry is adversely affected. To correct the distortion caused by exporting country's subsidy, the importing country can impose tariffs, hence capturing some of the competing firm's rents. Dixit (1988) showed that the optimal policy for the importing country is a partially countervailing or antidumping duty.[1]

For the past two decades the use of export subsidies and countervailing duties has been on the rise. The General Agreement on Tariffs and Trade (GATT)[2] allows the use of duties on the subsidised imports if the relevant industry can show that it falls in the so-called 'unfair trade' category, i.e., if the exports are either being dumped in the importing country or are being subsidised. A response by the importing country is usually a countervailing tariff or a voluntary export restraint. The impact of these impositions on the importing country has been studied by several authors, notably Staiger and Wolak (1992, 1994), Reitzes (1993) and Qiu (1995).

Staiger and Wolak (1992, 1994) use empirical model to show that the antidumping duties against a foreign monopoly restrict foreign imports and increase the share of the import-competing domestic firms. Reitzes (1993) and Qiu (1995) use a two period game between the governments (and firms) and analyse the effect of a

[1] Neils and Kate (1997) argue that it is better for the importing country's welfare to replace the antidumping duties with "competitive policy criteria" or, preferably, abolish it altogether. Although this might be a welfare superior strategy for the importing country, in reality most countries still use antidumping and countervailing duties in their trade wars, notably the US and EU against Japanese imports of electronics, automobiles etc.

[2] World Trade Organisation (WTO) since 1 January 1995.

VER or a countervailing duty once export subsidy is provided by the foreign country. Reitzes shows that the use of antidumping duty improves the domestic welfare when firms compete a' la Cournot but with Bertrand competition the effect is welfare worsening. Qiu shows that the countervailing duties, when imposed under GATT constraints and with delayed reactions, have no effect on the welfare of the two countries.

None of the above mentioned papers, however, assumes asymmetric information between the firms and the governments. However, in oligopolistic industries it is unlikely that the government has full information about the costs and demand of the firms. In this setting the trade literature has used the tools of regulation theory to analyse the impact of asymmetric information on the optimal policies of competing governments. The informational asymmetry is quite important in determining the injury claimed by the domestic firms. For instance, the Department of Commerce in the United States initiates an investigation only from the information provided to it by the interested party (firm with foreign competition). Also, several International Trade Commission (ITC) commissioners have complained about the quality of information, provided by the firms, they have to rely upon in order to make decisions on countervailing and antidumping duty cases.

This paper addresses the information problem and adds to the existing literature of international trade under asymmetric information. Most of the studies in international trade using asymmetric information approach have been in the so called third-market models, thus extending the Brander and Spencer (1985) model to the case in which governments are uninformed about either the cost or the demand

parameter.[3] Information asymmetry about marginal cost in the third-market setup has been analysed by Brainard and Martimort (1996, 1997), Collie and Hviid (1993), Qiu (1994), Maggi (2000) and Wright (1998), among others.[4]

Our paper extends Wright (1998) by considering a slightly different setup in which the government is not only concerned with the protection of its industry but also about the welfare of its consumers. Furthermore, we assume both governments use trade policy to influence the outcome in their country as the usual assumption of a government adopting non-interventionist policy unilaterally is not real.[5]

We develop a two-period game in which the home firm has private information about its costs which it signals to the foreign firm and both home and foreign governments by its choice of the first period output level. Based on some prior probability assessment, at the beginning of period 1 the home government chooses an optimal subsidy level after which the foreign government derives its optimal tariff. In the second period both firms compete in quantities. Based on the quantity level chosen by the home firm in the first period, the home and foreign governments choose their respective policy instruments in the same sequence as in the first period.

In this setup, the home firm has an incentive to misreperesnt itself by distorting its output away from the profit maximising level. In particular, we find that

[3] One notable exception is Rosendorff (1997) who studies the use of VERs and CVDs when the government is incompletely informed about the electoral returns from the two policy parameters. Also see recent papers by Cheng et al (2001) and Kolev and Prusa (2002).

[4] Within the same setup, some papers also consider the alternative trade policy instruments, i.e., VERs, quantity/subsidy restrictions with different combinations between home and foreign governments etc (see Cooper and Reizman, 1989; Shivakumar, 1993 and Caglayan and Usman, 2004).

[5] This is evident from recent US-Europe trade wars and also WTO negotiations. The tit-for-tat strategy in the recent 'banana wars' is a case in point. The US imposed up to 100% tariff on Scottish cashmere due to its claim that the EU was providing subsidies to banana growers in the Caribbean.

the home firm produces less in the presence of signalling than what it would produce when it does not signal its output level. For the home government it is optimal to give a higher subsidy (or a lower export tax) in the first period. This is because signalling commits a high cost firm to a lower output level in the first period and hence a smaller tax is needed to reduce this distortion and improve domestic welfare. Furthermore, we find that that the foreign government uses the same level of tariff whether the home firm signals its costs or not.

The rest of the paper is organised as follows. Basic framework is explained in next section while in sections 3 and 4 we derive the separating and pooling equilibira, respectively. Analysis of the results derived in sections 3 and 4 is presented in Section 5 and finally the last section concludes the paper.

2. The Basic Framework

Two firms, one located in the home and the other in the foreign country, produce homogeneous goods for consumption in the foreign country. The inverse demand function is given by $p = a - \left(q + q^*\right)$, where q and q^* are the quantities produced by the home and foreign firms, respectively and a is a positive parameter. Both governments use trade policy instruments to protect their respective firms. In addition, the foreign government also takes into account the consumer surplus which is given by $V = Q^2/2$ where $Q = q + q^*$.

The structure of the game is as follows. At the beginning of period 1 the home government commits to a subsidy for the home firm. After observing the subsidy chosen by the home government, the foreign government imposes tariff on its imports. At this stage neither the home and foreign governments nor the foreign firm knows the cost of the home firm, though it is common knowledge that it has either

low or high costs with $Prob(c=c^H) = \delta$. Marginal cost of the foreign firm is common knowledge and is denoted by c^*. At the last stage of period 1 both firms make their output decisions simultaneously, to maximise profits. After observing the output levels of the home firm, the uninformed agents update their beliefs about the costs of the home firm.

Based on the updated beliefs $\delta(q_1)$, both governments set their respective policy instrument levels to maximise welfare in period 2. Given the subsidy and tariff levels chosen by the governments and given the updated beliefs of the foreign firm, both firms choose output levels to maximise their second period profits.

Hence, the second period game is one of complete information and therefore the outcome is similar to Collie (1994). That is, when the domestic government is the Stackelberg leader in setting its trade policy, it realises that the foreign government will respond with a countervailing duty and hence the welfare maximising policy for the domestic firm is to impose an export tax on its firm.[6] The foreign government in turn uses a lower import tariff than the one used without home intervention. Given this outcome, the home firm has an incentive to overstate its costs in the first period which will result in lower home taxes and lower import tariffs hence resulting in higher profits in the second period.

Two distinct types of equilibria are possible in this setup: separating and pooling. In the case of separating equilibrium the home firm either plays q^L or q^H. The foreign firm and both governments then form a posterior belief function about the home firm's costs and based on this belief function, the government chooses an

[6] See Collie (1991, 1994) for a comparison with simultaneous move models.

optimal subsidy level s after which the foreign government responds with a countervailing duty.

In the case of pooling equilibrium the home firm uses the same output level regardless of its costs. In this case the foreign firm's and both governments' posterior beliefs are the same as their prior beliefs.

3. Separating Equilibria

Optimal Behaviour in Period 2

The choice of quantity in the first period in a separating equilibrium fully reveals the domestic firm's costs to the foreign firm and both governments. The second period game, therefore, is one of complete information. Given the first period cost information, the domestic government first chooses the subsidy level, s, after which the foreign government announces the level of its import tariff, t, and then both firms choose their outputs by maximising their respective profits, which are given by

$$\pi_2^i = \left(a - q_2^i - q_2^* - c^i + s_2^i - t_2^i\right) q_2^i \tag{1}$$

$$\pi_2^{*i} = \left(a - q_2^i - q_2^* - c^*\right) q^*, \quad i = L, H \tag{2}$$

The first order conditions for the maximisation problem give the reaction functions of each firm. Solving the two first order conditions simultaneously gives domestic and foreign outputs:

$$q_2^i = \frac{1}{3}\left(a - 2c^i + c^* + 2s^i - 2t^i\right) \tag{3}$$

$$q_2^* = \frac{1}{3}\left(a + c^i - 2c^* - s^i + t^i\right) \tag{4}$$

Next we solve for import tariffs which the foreign government imposes as a countervailing duty to the export subsidy given by the domestic firm in the first stage. The foreign government maximises consumer surplus, firm profits and the tariff revenue,

$$G^* = V\left(p^i\left(q_2, q_2^*\right), q_2^*\right) + \pi^*\left(q_2, q_2^*\right) + t_2^i q_2^i \tag{5}$$

Solving this yields the optimal tariff as a function of the domestic export subsidy, $t = \frac{1}{3}\left(a - c^i + s^i\right)$. At stage 1 the domestic government sets its subsidy to maximise domestic welfare realising that its subsidy will affect the optimal tariff set by the foreign government in stage 2. The home government therefore solves the following problem,

$$\max_{s_2^i}\left\{G_2^i = \pi_2^i\left(c^i, c^*\right) - s_2^i q_2^i\left(s_2, t_2\right)\right\} \tag{6}$$

The solution to this problem, taking account of the second stage tariff gives the optimal export subsidy,

$$s_2^i = -\frac{1}{40}\left(a - 4c^i + 3c^*\right) \tag{7}$$

and the import tariff then is given by

$$t_2^i = \frac{1}{40}\left(13a - 12c^i - c^*\right) \tag{8}$$

Faced with the prospect of a countervailing duty in the second stage, the optimal strategy for the domestic government is to use export tax in the first stage which will then result in a lower tariff. Substituting the values of subsidy and tariff the maximised home and foreign firm profits are given by

$$\pi_2^i\left(c^i, c^*\right) = \left(\frac{a - 4c^i + 3c^*}{10}\right)^2 \tag{9}$$

$$\pi_2^{*i}\left(c^i, c^*\right) = \left(\frac{9a + 4c^i - 13c^*}{20}\right)^2 \tag{10}$$

Given that there is an incentive for the domestic firm to misrepresent itself in the first period, we need to calculate the maximised profits when the actual costs in the first period are c^i but the home firm, via the output choice in first period, signals the costs as c^j,

$$\pi_2^{i|j}\left(c^{i|j}, c^*\right) = \left(\frac{a - 5c^i + c^j + 3c^*}{10}\right)^2 \tag{11}$$

Optimal Behaviour in Period 1

In period 1 the marginal cost of the home firm is private information and is therefore unknown to the foreign firm and both policymakers, home and foreign. As

before, at the beginning of the first period subsidy is chosen after which the tariff is decided and in the last stage both firms choose their respective output levels.

In separating equilibria the two types of the home firm choose different output levels, i.e., the high cost firm plays q^H while the low cost firm plays q^L. Thus the foreign firm's posterior beliefs associated with the home firm's high cost signal are, $\delta\left(q^H\right)=1$, and the posterior beliefs associated with the low cost signal are $\delta\left(q^L\right)=0$ and it suffices for any other signal q_1^i to be associated with the belief $\delta\left(q_1^i\right)=0$, $i = L, H$.

The optimal behaviour in period 1 must satisfy the following incentive compatible conditions

$$\pi_1^H\left(q_1^H, s_1, t_1\right)+\hat{\pi}_2^H \geq \pi_1^H\left(q_1^L, s_1, t_1\right)+\hat{\pi}_2^{H|L} \tag{12}$$

$$\pi_1^L\left(q_1^L, s_1, t_1\right)+\hat{\pi}_2^L \geq \pi_1^L\left(q_1^H, s_1, t_1\right)+\hat{\pi}_2^{L|H} \tag{13}$$

Eq (12) means that the high cost firm would prefer to produce q^H in period 1 and be perceived as high cost in period 2 rather than be perceived as low cost in period 2 and be forced to produce q^L in period 1. Note that tariff and the export tax (since optimal subsidy is negative) is lower for the high cost firm, therefore $\hat{\pi}_2^H > \hat{\pi}_2^{H/L}$.

Eq(13) states that low cost firm prefers to produce q^L in the first period and be perceived as low cost in period 2 rather than be perceived as high cost and forced to produce q^H in period 1. However, note that $\hat{\pi}_2^L < \hat{\pi}_2^{L|H}$ since when the low cost firm mimics a high cost one, import tariff and export tax are lower compared to the case

when the low-cost firm reveals the true costs. The low cost firm, therefore, has an incentive to deviate. Let $q_1^L\left(q_1^*, s_1, t_1\right)$ be the solution of $\arg\max \pi_1^L\left(q_1^L, s_1, t_1\right)$. Given $q_1^L\left(q_1^*, s_1, t_1\right)$, there are many q_1^H that satisfy eq (13). However, only one survives as part of separating equilibrium once the dominated strategies are eliminated when forming out-of-equilibrium strategies. Any output level less than $\underline{q}_1^H$ in fig 1 is a sequential separating equilibrium since the posterior belief after observing $\underline{q}_1^H$ is that $\delta\left(\underline{q}_1^H\right) = 0$. However, output $\underline{q}_1^H$ is dominated for the low cost firm by the output q_1^L and if the uninformed parties believe that the home firm will never choose a dominated output, then the only possible posterior beliefs after observing output $\underline{q}_1^H$ are $\delta\left(\underline{q}_1^H\right) = 1$. This overturns any equilibrium involving output less than $\underline{q}_1^H$ in favour of $\underline{q}_1^H$ as it yields higher profits. We can argue a similar case for any output greater than $\overline{q}_1^H$. Therefore the only separating equilibrium that survives after dominated strategies are eliminated when forming out-of-equilibrium beliefs are $q_1^L\left(q_1^*, s_1, t_1\right)$ and $\underline{q}_1^H\left(q_1^*, s_1, t_1\right) < q_1^H$.

The output level $q_1^L(.)$ is chosen only by the low cost firm and hence the low cost firm is able to obtain complete information profits. The high-cost firm, however, needs to distort its output away from the complete information level to convince the governments and the foreign firm that it is indeed high-cost. This distortion causes a cost on the high-cost firm as the output necessary to achieve this, $\underline{q}_1^H$, is lower than the complete information output.

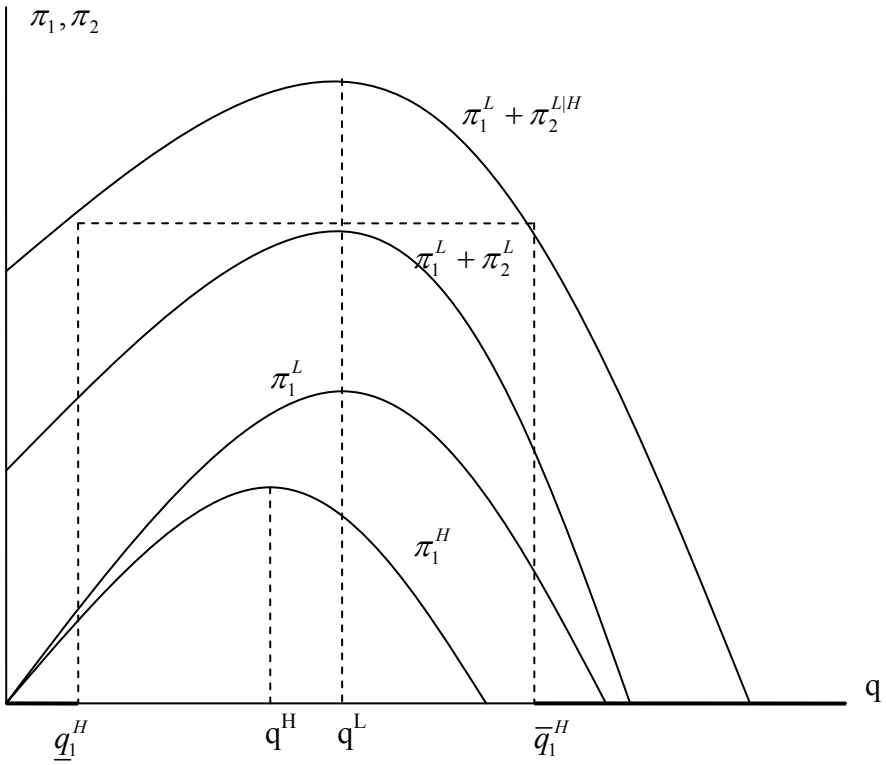

Fig 1 Separating equilibria of the signalling game

The outputs $\underline{q}_1^H$ and $q_1^L(.)$ satisfy eq (13) and therefore the incentive compatibility constraint for the low-cost firm is binding. Also, given that foreign firm maximises expected profits and that the home firm chooses the output level that creates distortion and high profits, the separating sequential equilibrium could be solved by simultaneously solving eq (13) and the following equations,

$$q_1^L\left(q_1^*, s_1, t_1\right) = \arg\max \pi_1^L\left(q_1^L, s_1, t_1\right) \tag{14}$$

$$q_1^*\left(q_1^H, q_1^L, s_1, t_1\right) = \arg\max\left\{\delta\pi_1^{*H}\left(q_1^H, q^* s_1, t_1\right) + (1-\delta)\pi_1^{*L}\left(q_1^L, q^*, s_1, t_1\right)\right\} \tag{15}$$

The solution of these equations yields $q_1^L(.)$, $q_1^H(.)$ and $q_1^*(.)$ as the unique separating equilibrium of the signalling game. Note that eq(13) is quadratic and therefore gives two solutions, $\underline{q}_1^H$ and $\overline{q}_1^H$, one of which yields higher profits and hence will be chosen by the home firm.

$$q_1^H = \frac{1}{3}\left(a - 2c^L + c^* + 2s - 2t\right) - \frac{(3+\delta)}{30}\sqrt{K} \tag{16}$$

$$q_1^L = \frac{1}{3}\left(a - 2c^L + c^* + 2s - 2t\right) - \frac{\delta}{30}\sqrt{K} \tag{17}$$

$$q_1^* = \frac{1}{3}\left(a - 2c^* + c^L + c^* - s + t\right) + \frac{\delta}{15}\sqrt{K} \tag{18}$$

where $K = 5\left(c^H - c^L\right)\left(2a - 3c^H - 5c^l + 6c^*\right) > 0$.[7]

Both governments take this equilibrium as given and choose the level of their respective policy instruments. Working backwards, the foreign government chooses

[7] See Appendix for the proof that K > 0.

import tariff by maximising its welfare and taking into account subsidy chosen in the first stage,

$$\max_{t_1} G_1^* = \delta\left[V\left(p\left(q_1^H, q_1^*\right)\right) + \pi_1^{*H}\left(q_1^H, q_1^*\right) + t_1 q_1^H(.)\right] + (1-\delta)\left[V\left(p\left(q_1^L, q_1^*\right)\right) + \pi_1^{*L}\left(q_1^L, q_1^*\right) + t_1 q_1^L\right] \tag{19}$$

The home government similarly maximises its welfare to choose export subsidy knowing the reaction of the foreign government in the next stage,

$$\max_{s_1} G_1 = \delta\left[\pi_1^H\left(q_1^H, q_1^*\right) - s_1 q_1^H\left(s_1, t_1\right)\right] + (1-\delta)\left[\pi_1^L\left(q_1^L, q_1^*\right) + s_1 q_1^L\left(s_1, t_1\right)\right] \tag{20}$$

where π is obtained by substituting the separating equilibrium of the output game into home firm profit. Solving the first conditions for this problem yields the optimal subsidy,

$$s_1 = -\frac{1}{40}\left(a - 4c^L + 3c^*\right) - \frac{9\delta}{10}\left(c^H - c^L\right) + \frac{\delta}{5}\sqrt{K} \tag{21}$$

Putting the value of subsidy in the tariff obtained from solving eq(19) we get

$$t_1 = \frac{1}{40}\left(13a - 12\bar{c} - c^*\right) \tag{22}$$

Finally, putting these values in the separating equilibrium outputs, eqs(16)-(18) , gives

$$\hat{q}_1^H = \frac{1}{10}\left(a - 4\bar{c} + 3c^*\right) - \frac{(1-\delta)}{10}\sqrt{K} \tag{23}$$

$$\hat{q}_1^L = \frac{1}{10}\left(a - 4\overline{c} + 3c^*\right) + \frac{\delta}{10}\sqrt{K} \tag{24}$$

$$\hat{q}_1^* = \frac{1}{20}\left(9a + 4\overline{c} - 13c^*\right) \tag{25}$$

where $\overline{c} = \delta c^H + (1-\delta)c^L$.

4. Pooling Equilibrium

In a pooling equilibrium both types of home firm produce the same level of output in the first period and hence the prior beliefs of the foreign firm and both governments are also the posterior beliefs. As before we will first solve for period 2 levels and then move back to period 1.

Period 2

Given beliefs and the subsidy and tariff, the home firm maximises profits as in period 2 in section 4.4 and the foreign firm maximises expected profits given by,

$$\max_{q_{2p}^i} E\pi_2^* = \delta\left(a - q_2^H - q_2^* - c^*\right)q_2^* + (1-\delta)\left(a - q_2^L - q_2^* - c^*\right)q_2^* \tag{26}$$

Solving the three first order conditions simultaneously yields the Bayesian-Cournot equilibrium quantities. Putting these values in the profit functions give us the maximised profits for both firms. Using these profit values, the governments of both countries maximise their welfares as before in a sequential fashion with the home government setting the subsidy first followed by the foreign government. Maximising the expected welfares and solving for s and t, we get

$$s_{2p} = -\frac{1}{40}\left(a + 4\overline{c} - 3c^*\right) \tag{27}$$

$$t_{2p} = \frac{1}{40}\left(13a - 12\overline{c} - c^*\right) \tag{28}$$

where p in the subscript refers to the pooling equilibrium. Putting these values in the firms' quantities we get the following:

$$\hat{q}_{2p}^H = \frac{1}{10}\left(a + \overline{c} - 5c^H + 3c^*\right) \tag{29}$$

$$\hat{q}_{2p}^L = \frac{1}{10}\left(a + \overline{c} - 5c^H + 3c^*\right) \tag{30}$$

$$q_{2p}^* = \frac{1}{20}\left(9a + 4\overline{c} - 13c^*\right) \tag{31}$$

Period 1

For the home firm, the output level chosen in first period to be part of the pooling equilibrium, the same level of output must be chosen by the high- and low-cost firm. The following are the necessary and sufficient conditions for an output level q_1^p to be part of the pooling equilibrium,

$$\pi_{1p}^H\left(q_{1p}^H, s_1, t_1\right) + \hat{\pi}_{2p}^H \geq \pi_1^H\left(q_1^H, s_1, t_1\right) + \hat{\pi}_2^H$$

$$\pi_{1p}^L\left(q_{1p}^L, s_1, t_1\right) + \hat{\pi}_{2p}^L \geq \pi_1^L\left(q_1^L, s_1, t_1\right) + \hat{\pi}_2^L$$

Again we will have multiple equilibria emerging in this setup as any output level q_1^p with beliefs $\delta\left(q_1\right) = 0$ if $q_1 < q_1^p$, $\delta\left(q_1\right) = 1$ if $q_1 > q_1^p$ and $\delta\left(q_1\right) = \delta$ if $q_1 = q_1^p$, can

be part of the pooling equilibrium. However, none of these output levels survive as part of the equilibrium once dominated strategies are eliminated when forming out-of-equilibrium beliefs. Take output level q_1^p. It forms the pooling equilibrium only because after observing an output level q_1^L the posterior beliefs of the foreign firm and both governments are that $\delta\left(q_1^L\right)=1$. Nevertheless, output q_1^L is dominated by output q_1^p for the high cost firm. And hence if the foreign firm and the governments believe that the home firm will never choose a dominated output, the only posterior beliefs upon observing q_1^L is $\delta\left(q_1^L\right)=0$. This overturns any equilibrium involving q_1^L because the posterior beliefs on which it is based are found be implausible. A similar argument applies to any other out-of-equilibrium output level. Therefore, using the intuitive criteria, there does not exist any pooling equilibria and the only possible outcome of such a game is a separating equilibrium.

5. Analysis and Discussion

In this section we analyse the policy choices of all players in this trade game, i.e., both firms and both governments. We compare the levels of output and the level of trade policy instruments of the signalling and non-signalling equilibria. Thus comparing eqs(21-22) and (27-28), (23-24) and (29-30), (25) and (31), we get

Proposition 1: *(i) The optimal subsidy is higher when the home firm signals costs compared to the case when the firm does not signal costs while tariff levels for both cases are the same.*

$$s_1 > \hat{s}_{2p} \tag{32}$$

$$t_1 = \hat{t}_{2p} \tag{33}$$

(ii) The home firm output when cost is low (high) is higher (lower) under signalling equilibrium compared to the non-signalling equilibrium, while the foreign firm output is the same for both cases.

$$q_1^H < \hat{q}_{2p}^H \tag{34}$$

$$q_1^L > \hat{q}_{2p}^L \tag{35}$$

Proof: See Appendix

The intuition behind the above result is as follows. Given the strategy of the two policymakers, the low cost home firm has an incentive to present itself as high cost since that will mean lower export tax and also a lower tariff in the second period. Therefore, the high cost firm must distort its output away from the one that maximises profits when there is no signalling. The distortion is below the profit maximising level since that will deter a low cost firm from mimicking as a high cost one and since the expected output is the same in signalling and non-signalling cases, $Eq_1 = E\hat{q}_{2p}$, we get eq (35).

As regards the policymakers, for the home government it is optimal to impose a lower tax in the first period. This is because signalling commits a high cost firm to a lower output level $\underline{q}_1^H\left(q_1^*, s_1, t_1\right) < q_1^H$ in the first period and hence a smaller tax is needed to reduce this distortion and improve domestic welfare. Furthermore, a reduced export tax increases the production of both types of firms but since signalling tends to reduce the high cost firm's output, the *expected* output of the home firm is the same in signalling and non-signalling cases. This in turn results in the same level of expected output by the foreign firm and the same level of tariff by the foreign government whether the home firm signals its costs or not.

6. Conclusion

This paper has explored the role of information in the formulation of trade policy for home and foreign country, in a setting in which the home government chooses its subsidy level first after which the foreign firm retaliates by imposing tariffs on its imports. We have analysed the effect on optimal levels of policy instruments in an environment in which home firm costs are private information but it can signal these costs to both policymakers and the foreign firm by choosing the appropriate output level.

The benchmark case of complete information for this Stackelberg game showed that the best policy for the home government is to impose an export tax on its firm since that results in a lower tariff by the foreign government. Then, under asymmetric information, the low cost firm has an incentive to mimic the inefficient one by choosing the output level of a high cost firm. The high cost firm, in order to prove that it indeed has high costs distorts its output below the profit maximising level. Since signalling creates a distortion, it is optimal for the home government to use a lower export tax in the first period. However, since the expected home firm output is same in signalling vs. non-signalling equilibria, the optimal policy for the foreign government is to use the same level of tariff regardless of home firm's first period actions, and similarly the foreign firm produces the same level of output.

Although there are a number of other retaliating instruments to an export subsidy, in practice governments only use tariffs to respond to a subsidy. Since domestic welfare is maximised by imposing an export tax when the home government anticipates tariffs from the importing country, it seems that the actual policy of giving a subsidy is based on some other factors, as it is clearly welfare worsening. One can therefore argue that the presence of asymmetric information is at least one of the

culprits since a significant distortion of the output level by the home firm could result in the home government giving a subsidy to reduce distortion, when it is actually not the best policy. Since, in this particular setup, our results show that neither the import tariffs nor the foreign output is affected, the home firm can benefit from it at the expense of domestic welfare.

Although the paper is far from conclusive, it could be used to argue that the use of profit-shifting subsidies may have undesirable consequences for a country's welfare when governments are incompletely informed about the costs of firms. Therefore, it is important that policymakers take informational limitations into account when designing trade policies.

Appendix

Proof that K > 0.

Solving (3) and (4) in the text gives us $q_2^H = \frac{1}{10}\left(a - 4c^H + 2c^*\right)$. For the interior solution of the home firm output, we need

$$a - 4c^H + 2c^* > 0 \tag{A1}$$

Multiplying (A1) by 2 we get

$$2a - 8c^H + 4c^* > 0 \tag{A2}$$

Finally noting that $c^H - c^L > 0$ and adding $5\left(c^H - c^L\right) + 2c^*$ in (A2), we get

$$2a - 3c^H - 5c^L + 6c^* > 0 \tag{A3}$$

Hence K > 0.

Proof of Proposition 1

(i) Subtracting eq(27) from eq(21) in the text, we get

$$s_1 - \hat{s}_{2p} = -\delta\left(c^H - c^L\right) + \frac{\delta}{5}\sqrt{K} \tag{A4}$$

From (A2) and the fact that $5c^H > 5c^L$ we get

$$2a - 3c^H - 5c^L + 6c^* > 5\left(c^H - c^L\right) \tag{A5}$$

Therefore $\sqrt{K} > 5\left(c^H - c^L\right)$ and hence $s_1 > \hat{s}_{2p}$.

(ii) Subtracting eq(29) from (23) and (30) from (24), we get, respectively

$$q_1^H - q_{2p}^H = \frac{1}{2}(1-p)\left(c^H - c^L\right) - \frac{1}{10}(1-p)\sqrt{K}$$

$$q_1^L - q_{2p}^L = -\frac{1}{2}\delta\left(c^H - c^L\right) + \frac{\delta}{10}\sqrt{K}$$

From (A5) we know that $\sqrt{K} > 5\left(c^H - c^L\right) > 0$ and therefore $q_1^H < q_{2p}^H$ and $q_1^L > q_{2p}^L$.

References

Brainard, L and D. Martimort (1996), "Strategic Trade Policy Design with Asymmetric Information and Public Contracts", *Review of Economic Studies* 63: 81-105.

Brainard, L and D. Martimort (1997), "Strategic Trade Policy with Incompletely Informed Policymakers", *Journal of International Economics* 42: 221-238.

Brander, J.A. and B. Spencer (1985), "Export Subsidy and International Market Share Rivalry", *Journal of International Economics*, 18: 83-100.

Caglayan, M. and Usman, M. (2004), "Incompletely Informed Policymakers and Trade Policy in Oligopolistic Industries", *Manchester School*, 72(3): 283-297.

Cheng, L.K., L.D. Qiu and K.P. Wong (2001), "Anti-dumping Measures as a Tool of Protectionism: A Mechanism Design Approach", *Canadian Journal of Economics* 34: 639-660.

Collie, D. (1991), "Export Subsidies and Countervailing Tariffs", *Journal of International Economics*, 31: 309-324.

Collie, D (1994), "Endogenous Timing in Trade Policy Games: Should the Government use Countervailing Duties?", *Weltwirtschaftlisches Archiv* 130: 327-339.

Collie, D. and Hviid, M. (1993), "Export Subsidies as Signals of Competitiveness", *Scandinavian Journal of Economics*, 95: 327-339.

Cooper, R. and Riezman, R. (1989). 'Uncertainty and Choice of Trade Policy in Oligopolistic Industries', *Review of Economic Studies*, 56: 129–140.

Dixit, A.K. (1988), "Antidumping and Countervailing Duties Under Oligopoly", *European Economic Review* 32: 55-68.

Kolev and Prusa (2002), "Dumping and Double Crossing: The (In)effectiveness of Cost-Based Trade Policy Under Incomplete Information", *International Economic Review*, 43(3): 895- 918

Maggi, G. (2000), "Strategic Trade Policy under Incomplete Information", *International Economic Review* 40: 571-594.

Neils, G. and Kate, A. (1997), "Trust Anti-trust to Dump Antidumping: Abolishing Antidumping in Free Trade Agreements without Replacing it with Competition Law", *Journal of world trade*, 31: 29-43

Reitzes, J. (1993), "Antidumping Policy", *International Economic Review* 34: 745-763.

Rosendorf, B.P. (1996), "Voluntary Export Restraints, Antidumping Procedure and Domestic Politics", American Economic Review 86: 544-561.

Shivakumar, R. (1993). 'Strategic Trade Policy: Choosing between Export Subsidies and Export Quotas under Uncertainty', *Journal of International Economics*, 35: 169–183.

Staiger, R. and F. Wolak (1992), "The Effect of Domestic Antidumping Law in the Presence of Foreign Monopoly", *Journal of International Economics* 32: 265-287.

Staiger, R. and F. Wolak (1994), "Measuring Industry-Specific Protection: Antidumping in the United States", *Brookings Paper on Economics Activity*, 51-118.

Qiu, L.D. (1994), "Optimal Strategic Trade Policy under Asymmetric Information", *Journal of International Economics* 36: 333-354.

Wright, D. (1998), "Strategic Trade Policy and Signalling with Unobservable Costs", *Review of International Economics*, 6: 105-119.