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Xenia Matschke
University of Connecticut

Anja Schottner
University of Bonn

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Recommended Citation
Matschke, Xenia and Schottner, Anja, "Antidumping Duties Under Asymmetric Cost Information" (2007). *Economics Working Papers.* Paper 200739.
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University of Connecticut

Department of Economics Working Paper Series

Antidumping Duties Under Asymmetric Cost Information

Xenia Matschke
University of Connecticut

Anja Schottner
University of Bonn

Working Paper 2007-39

October 2007

341 Mansfield Road, Unit 1063
Storrs, CT 06269–1063
Phone: (860) 486–3022
Fax: (860) 486–4463
http://www.econ.uconn.edu/

This working paper is indexed on RePEc, http://repec.org/

Abstract

In the last two decades, trade liberalization under GATT/WTO has been partly offset by an increase in antidumping protection due to the inclusion of sales below cost in the definition of dumping. The cost-based definition gives regulating authorities an opportunity to choose protection according to their liking. This paper investigates the domestic government's antidumping duty choice in an asymmetric information framework where the foreign firm's cost is observed by the domestic firm, but not by the government. To induce truthful revelation, the government can design a tariff schedule, contingent on firms' cost reports, accompanied by a threat to collect additional information for report verification (i.e., auditing) and, in case misreporting is detected, to set penalty duties. We devise a mechanism where the domestic and foreign firm may be asked to provide cost reports under which the full-information, i.e., efficient, tariffs are implementable. We also discuss the conditions under which this policy is optimal and when it may be better to instead adopt a "facts available" policy, i.e., a policy where no information from the foreign firm is solicited.

Journal of Economic Literature Classification: F13, F16

Keywords: antidumping duties, asymmetric information, trade protection

ANTIDUMPING DUTIES UNDER ASYMMETRIC COST INFORMATION

XENIA MATSCHKE AND ANJA SCHÖTTNER

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Date: This version: October 2, 2007.

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1. Introduction

Trade liberalization under GATT/WTO has been an impressive success. Not only have average tariff levels been lowered considerably, but additional product categories not included in previous trade liberalization agreements have also recently become subject to the general liberalization process, e.g. agricultural products and textiles. Yet, right from the beginning, trade liberalization under GATT was not without exceptions. In fact, one major reason why the number of countries signing off on the GATT increased so considerably was probably that the agreement contained numerous provisions to allow participants to "withdraw – or cease to apply – their normal obligations in order to protect (safeguard) certain overriding interests." (Hoekman and Kostecki, 2001, p.303). One such exception provision that has proved especially popular are antidumping measures. Article VI of GATT stipulates that member countries can impose antidumping duties on products that are imported at below-normal value and cause material injury to a domestic industry. During the first decades of the GATT, antidumping duties were used rather infrequently. This changed with the completion of the GATT Tokyo Round in 1979, when the antidumping statute was amended. First, the definition of selling below fair or normal value was extended to include sales below cost; i.e., these days the "fair/normal value" is more likely to be a value constructed from cost estimates and "reasonable" additions rather than being an observable market price. Moreover, it was no longer deemed necessary to prove that dumping was the principal cause of material injury (Blonigen and Prusa, 2003). These changes eventually resulted in a veritable antidumping "boom". Whereas the successful completion of the Uruguay Round led to considerable progress in bringing down average tariff rates and increasing the product range to which trade liberalization applied, a parallel movement to increase trade protection under the cloak of "fair trade" took place: From 1995 to 1999, the number of antidumping actions increased more than six-fold, and the number of users increased dramatically as well, with developing countries starting to add antidumping to their trade policy toolkit (Hoekman and Kostecki, 2001, p.316).

It has been well recognized by trade economists that "dumping", in particular when employing the cost-based definition, is a flexible term and can be used rather

arbitrarily to impede foreign competition in the domestic market, thus creating a new protectionism under the auspices of GATT/WTO (Blonigen and Prusa, 2003). In this paper, we investigate how optimal antidumping duties (in the sense of domestic welfare-maximizing) are calculated, given that the domestic government, i.e., the antidumping authority, does not have a priori knowledge of the true costs of foreign firms. Since the government does not have the cost information, but the foreign firms and maybe even the domestic firms do, it makes sense to consider the question of optimal antidumping duties in an asymmetric information framework. In particular, we show how the domestic antidumping authority can use optimal mechanism design to obtain the foreign cost information. We also discuss the conditions under which it is optimal to gather information from both domestic and foreign firms and when it may be better to instead adopt a "facts available" policy, i.e., a policy where no information from foreign firms is solicited.

The market structure in this paper is a Cournot duopoly with one domestic firm and one foreign firm, where the foreign firm's cost is unknown to the antidumping authority, similarly to the setup in Cheng, Qiu, and Wong (2001). However, our paper is different from theirs in that, in line with reality, we do not allow lump sum payments from the government to the firms as an instrument to extract the true cost information. Moreover, we do not require that the antidumping duty be conditional on any real existing dumping margin. In principle, dumping implies that a firm either sells a good below the price in another market or below cost plus some "reasonable" profit, administrative and sales cost additions. However, it has been well documented that in antidumping investigations, dumping margin calculations, especially in the increasingly popular case when dumping is determined based on cost information, are routinely set up in such a way that the authorities find evidence of dumping, regardless of the underlying facts. For this reason, the question then becomes what antidumping duty the authority wants to levy. The focus on the determination of an optimal antidumping duty regardless of whether dumping has actually occurred can also be found in Kolev and Prusa (2002). They consider a signaling framework where the foreign firm may send a high-cost signal by restraining its exports voluntarily.

In this paper, we investigate a different aspect of antidumping investigations; namely, that the domestic authority may ask foreign firms, who have been accused of dumping, to disclose their cost information. Any information received from foreign firms is then considered together with the domestic petitioners' claims about foreign cost and may be further supplemented by the domestic authority's own findings. We model this information acquisition process by assuming that the domestic authority first decides whether to ask the foreign firm to state its cost or whether to rely only on the information from the domestic firm, and then determines whether or not to gather additional information in order to verify possibly conflicting claims. To implement the optimal mechanism, the authority chooses report-specific antidumping duties, auditing probabilities, and punitive duties in case a firm has been caught lying. Kohler and Moore (2001) also model auditing during an antidumping investigation, but they assume perfect competition, and the asymmetric information in their paper is about domestic cost and whether or not material injury has occurred.

The remainder of the paper is organized as follows: Section 2 presents the basic model. Section 3 discusses the case when the government only solicits cost information from the domestic firm, whereas Section 4 is about the case when both the domestic and the foreign firm provide cost reports. Both Sections 3 and 4 assume that auditing is perfect and thus always detects untruthful cost reports, whereas in Section 5, auditing is assumed to be imperfect. In Section 6, we discuss what happens when the government cannot commit to auditing ex-post. Section 7 concludes.

2. The Model

Consider a country with a linear inverse market demand function $p = a - bQ$, where p is price, Q is quantity, and $a, b > 0$. Let the market be served by two firms, one domestic (firm 1) and one foreign (firm 2), that compete in Cournot fashion in a one-shot game. Denote their output levels by q_1 and q_2 where $q_1 + q_2 = Q$. The domestic firm has constant marginal cost c_1 and the foreign firm has constant marginal cost c_2. Fixed costs are assumed to be zero for both firms.

If the government sets a specific import tariff (antidumping duty) t, the firms produce

$$q_1(t) = \frac{a + c_2 + t - 2c_1}{3b}, \quad q_2(t) = \frac{a + c_1 - 2(c_2 + t)}{3b} \quad \text{if } t \leq t_0,$$

where t_0 is the tariff at which the foreign firm shuts down production, i.e., $t_0 = (a + c_1 - 2c_2)/2$. For our model to make sense, firm 2 must produce in the absence of any governmental intervention, i.e. $q_2(0) > 0$. For simplicity, we also assume that $q_1(0) > 0$.

The home firm initiates an antidumping investigation by filing a dumping complaint and providing information about the alleged dumping. Here, we assume that the domestic firm provides information about the foreign firm's cost parameter c_2. Based on its beliefs about foreign cost, the home government (antidumping authority) wants to choose the antidumping duty t that maximizes domestic welfare. Since $t > t_0$ leads to the same allocation as $t = t_0$, the government can restrict its choice to $t \in [0, t_0]$. Hence, the domestic welfare is given by

$$W(c_2, t) = V(c_2, t) + \Pi_1(c_2, t) + T(c_2, t) \tag{2.1}$$

where $V = (2a - c_1 - c_2 - t)^2/(18b)$ denotes consumer surplus, $\Pi_1 = (a + c_2 + t - 2c_1)^2/(9b)$ the domestic profit, and $T = t(a + c_1 - 2c_2 - 2t)/(3b)$ the tariff revenue. The efficient tariff that maximizes (2.1) is given by

$$t^* = \frac{a - c_2}{3} \tag{2.2}$$

and is decreasing in the foreign firm's marginal cost. Notice that in order to set the efficient tariff, knowledge about the domestic cost parameter is not needed. However, the domestic government does need to know the foreign firm's marginal cost c_2.[1]

The cost parameter c_2 is observed by both firms, but not by the government. A priori, the latter only knows that $c_2 = c_H$ with probability α and $c_2 = c_L$ with probability $1-\alpha$, where $\alpha \in (0, 1)$ and $c_L < c_H$. We denote the corresponding efficient (welfare-maximizing full information) tariffs by t_H^* and t_L^*, respectively.

[1] To avoid tedious discussions of corner solutions, we assume that $t^* > 0$ for all possible realizations of c_2.

The government can try and induce firms to truthfully reveal their cost information. To do so, it ex-ante announces a differentiated tariff schedule and auditing probabilities that are both contingent on firms' cost reports. By conducting an audit, the government is able to verify firms' reports, thereby incurring cost $A \geq 0$. This audit can be thought of as gathering additional information about foreign cost from independent sources. For simplicity, we assume for now that the audit will always uncover the true cost parameter. The case of imperfect auditing is discussed in Section 5.

Throughout the paper, we assume that tariffs are contractible so that the government can ex-ante commit to a tariff schedule, even if it might ex-post lead to suboptimal measures.[2] Initially, we also assume that auditing probabilities can be contracted upon. However, since compliance with an auditing scheme is particularly difficult to verify, we analyze the implications of non-contractible auditing in Section 6. Furthermore, lump sum payments to or from firms are not feasible in our model.[3]

3. Using only information provided by the domestic firm

We first look at the case where the government relies only on the information about foreign cost provided by the home firm in its dumping complaint. The foreign firm is not asked to make a statement about its cost.[4] Depending on the home firm's

[2]For example, the foreign firm can be prevented from overstating c_2 if the government ex-ante credibly commits to implementing an inefficiently high tariff in case it detects cost exaggeration. The problem is that such a tariff scheme is not self-enforcing since ex-post the government prefers to impose the tariff t_L^*. However, if the tariff scheme can be contracted upon, inefficiently high tariffs will be demanded (i.e., enforced) by the domestic firm that benefits from a higher tariff. Alternatively, the tariff scheme will be self-enforcing if the government sufficiently cares about its reputation in future anti-dumping cases. The analysis of such a reputational equilibrium in a repeated game is beyond the scope of this paper and is left for future research.

[3]Payments from firms to the antidumping authority would be viewed as attempted bribery and are thus not allowed. Payments from the authority to firms are considered as trade-distorting subsidies forbidden under the WTO. For example, the Byrd amendment, that distributed antidumping revenue to petitioning firms in the U.S., was ruled in violation with WTO rules in 2003 and had to be scrapped.

[4]Prior to 1994, it was rather common that under a procedure called "facts available", only information from domestic petitioners was taken into account and information provided by foreign firms

report $i \in \{L, H\}$, the government audits with probability $\theta_i \in [0, 1]$. If no audit takes place or if the audit confirms the firm's report, the government implements the tariff t_i. However, if the government conducts an audit and detects a misrepresentation of the foreign firm's cost, the tariff f_i – intended to punish an untruthful report – will be imposed.

The government's problem of maximizing expected domestic welfare subject to truthful cost revelation by the domestic firm thus looks as follows:

$$\max_{t_L, t_H, f_L, f_H, \theta_L, \theta_H} \{\alpha[W(c_H, t_H) - \theta_H A] + (1 - \alpha)[W(c_L, t_L) - \theta_L A]\}$$

subject to the constraints

$$\Pi_1(c_H, t_H) \geq (1 - \theta_L)\Pi_1(c_H, t_L) + \theta_L \Pi_1(c_H, f_H), \tag{3.1a}$$

$$\Pi_1(c_L, t_L) \geq (1 - \theta_H)\Pi_1(c_L, t_H) + \theta_H \Pi_1(c_L, f_L). \tag{3.1b}$$

Inequalities (3.1a) and (3.1b) are the domestic firm's incentive compatibility constraints when the foreign firm's cost parameter is c_H and c_L, respectively. We do not consider any participation constraints for the domestic firm since it already provides information about c_2 in the antidumping petition.[5]

To find the solution to this optimization problem, we first relax it by dropping constraint (3.1b); this seems reasonable because if $c_2 = c_L$, then the domestic firm would have no incentive to lie about cost, provided that $t_L \geq t_H$, which will presumably hold given that $t_L^* > t_H^*$. We next show that the solution of this relaxed problem also satisfies the constraint previously dropped and hence also solves the original problem.

At the optimal solution of the relaxed problem, $\theta_H = 0$ whereas f_L can be chosen arbitrarily. Considering the incentive compatibility constraint for the high cost case, the harshest punishment that the government can inflict on a lying domestic firm is to set $f_H = 0$; i.e., the government rejects the domestic firm's dumping claim

was disregarded. During the Uruguay Round, trading partners agreed on limiting the lopsidedness of this procedure, but in practice, it seems that administrators have not fundamentally improved upon the application of "facts available", see Moore (2006) for a thorough discussion.

[5]Even without this assumption, the participation constraints could always be easily satisfied by choosing appropriately low punishment tariffs in case the domestic firm provides no cost information.

and does not impose any antidumping duty. The relaxed maximization problem can therefore be rewritten as

$$\max_{t_L, t_H, \theta_L} \{\alpha W(c_H, t_H) + (1-\alpha)[W(c_L, t_L) - \theta_L A]\}$$

subject to

$$\Pi_1(c_H, t_H) \geq (1-\theta_L)\Pi_1(c_H, t_L) + \theta_L \Pi_1(c_H, 0). \tag{3.2}$$

After solving this problem and verifying that the solution also satisfies (3.1b), we obtain the following result; see Appendix A for details.

Proposition 3.1. *For the case where only the domestic firm provides cost information, it is optimal for the government to audit with a strictly positive probability only if a low-cost report arrives. The optimal tariff t_L for the low-cost firm is above the optimal tariff t_H for the high-cost firm; but t_H is above the efficient tariff t_H^*, and t_L is below the efficient tariff t_L^* except for the case that auditing is costless. In case the domestic firm is caught lying, a penalty tariff $f_H \leq t_H$ will be imposed, but in equilibrium, lying never occurs.*

The larger the gap between the low- and the high-cost tariff, $t_L - t_H$, the higher is the domestic firm's incentive to deliver an untruthful report if $c_2 = c_H$. To sustain truthful revelation, the government can therefore increase $t_L - t_H$ only by raising the auditing probability. Trading off the implementation of more favorable tariffs versus expected auditing cost, the government optimally chooses a tariff gap that is smaller than $t_L^* - t_H^*$. Implicit differentiation of the first-order conditions (A.3) and (A.4) in Appendix A yields that $t_L - t_H$ decreases in A and increases in α. Intuitively, the higher the auditing cost A, the more expensive it is to implement a large tariff gap. By contrast, the higher the probability that the foreign firm is a high-cost type, the less likely it is that a low-cost report arrives. Consequently, auditing costs have to be incurred less often, thereby making a larger tariff gap optimal.

4. Soliciting additional information from the foreign firm

4.1. **The foreign firm is always asked to report.** Instead of using only the domestic firm's report as primary source for information on c_2, the government can also ask the foreign firm for its cost information. Soliciting cost information from the

foreign firm leads to an additional fixed cost K, which is distinct from the auditing cost A and consists of preparing a questionnaire, sending it to the foreign firm, and processing the information. In contrast, obtaining information from the domestic firm is costless or at least less costly[6], given that it already provides the cost information in its antidumping petition.

In this section, we examine the case where the government always asks the foreign firm for cost information after a dumping complaint has been filed. Let θ_{ij} be the audit probability if firm 1 reports cost as i and firm 2 reports j, where $i, j \in \{L, H\}$. When the reports coincide, i.e., $i = j$, a tariff t_{ii} is imposed if no audit takes place or if an audit takes place and the reports are found to be correct. However, if the audit detects lying, tariffs are h_{ii} if $c_2 = c_H$ and l_{ii} if $c_2 = c_L$. When firms' reports differ and no audit takes place, tariff t_{ij} is implemented. In case the government audits, it imposes a tariff h_{ij} if it turns out that $c_2 = c_H$, and l_{ij} if the audit reveals that $c_2 = c_L$. Finally, let f be the tariff that the domestic government chooses if the foreign firm refuses to participate, i.e., does not provide the requested cost information.

We assume that the government wishes to implement truthful reporting of both firms as a unique Nash equilibrium. To solve the government's problem, we proceed in two steps. First, we determine a welfare-maximizing combination of tariffs and audits under which truth-telling is a Nash equilibrium. Next, we show that given these tariffs and auditing probabilities, this equilibrium is also unique.

To ensure that providing correct cost information constitutes a Nash equilibrium, the government chooses $\{t_{ij}, t_{ii}, h_{ij}, l_{ij}, f, \theta_{ij}, \theta_{ii}\}$ to maximize

$$\alpha[W(c_H, t_{HH}) - \theta_{HH}A] + (1-\alpha)[W(c_L, t_{LL}) - \theta_{LL}A] - K,$$

[6]The information provided by the domestic firm needs to be processed as well, but the antidumping authority has no choice but to incur this cost, and this cost is presumably lower than the cost of gathering and processing information from abroad. The parameter K is thus best understood as the difference between obtaining cost information from both firms versus obtaining such information from only the domestic firm.

subject to the constraints that

$$\Pi_1(c_H, t_{HH}) \geq (1-\theta_{LH})\Pi_1(c_H, t_{LH}) + \theta_{LH}\Pi_1(c_H, h_{LH}), \tag{4.1a}$$

$$\Pi_1(c_L, t_{LL}) \geq (1-\theta_{HL})\Pi_1(c_L, t_{HL}) + \theta_{HL}\Pi_1(c_L, l_{HL}), \tag{4.1b}$$

$$\Pi_2(c_H, t_{HH}) \geq (1-\theta_{HL})\Pi_2(c_H, t_{HL}) + \theta_{HL}\Pi_2(c_H, h_{HL}), \tag{4.1c}$$

$$\Pi_2(c_L, t_{LL}) \geq (1-\theta_{LH})\Pi_2(c_L, t_{LH}) + \theta_{LH}\Pi_2(c_L, l_{LH}), \tag{4.1d}$$

$$\Pi_2(c_H, t_{HH}) \geq \Pi_2(c_H, f), \tag{4.1e}$$

$$\Pi_2(c_L, t_{LL}) \geq \Pi_2(c_L, f). \tag{4.1f}$$

The first two constraints are the incentive compatibility constraints for firm 1, the next two are the incentive compatibility constraints for firm 2, and the last two are the participation constraints for the high- and the low-cost type of firm 2.

First note that (4.1b) and (4.1c) are easily satisfied by announcing $\theta_{HL} = 0$ and a tariff t_{HL} such that $t_{HH} \leq t_{HL} \leq t_{LL}$.[7] Intuitively, to achieve a high tariff, the domestic firm will not misrepresent a low cost parameter. Similarly, to promote the implementation of a low tariff, the foreign firm will not lie about high cost. Moreover, there are several ways to ensure that the efficient tariffs t_H^* and t_L^* are incentive-compatible. Because of its intuitive appeal and to guarantee uniqueness of the equilibrium, we pick the following incentive scheme: The government announces to always audit if the foreign firm claims to have high cost while the domestic firm insists on a low cost parameter. It then implements an inefficiently low tariff to punish the domestic firm if it turns out that $c_2 = c_H$ and an inefficiently high tariff otherwise. Formally, the ex-ante announced scheme comprises $\theta_{LH} = 1$, $t_{HH} = t_H^* > h_{LH}$ and $t_{LL} = t_L^* < l_{LH}$. Finally, firm 2's participation constraints are satisfied if $f \geq t_L^*$. It is unnecessary to audit when identical reports arrive, hence $\theta_{HH} = \theta_{LL} = 0$. Obviously, this combination of tariffs and auditing probabilities maximizes the government's objective function.

It remains to verify that truth-telling is indeed the only Nash equilibrium under the proposed incentive scheme. Consider the case $c_2 = c_L$. The reports $i = L$ and $j = H$ cannot constitute a Nash equilibrium since the foreign firm can increase

[7] Under the optimal tariff scheme, $t_{HH} \leq t_{LL}$ always holds.

its profit by stating its true cost, thereby avoiding a punishing tariff. The reports $i = j = H$ are not a Nash equilibrium since the domestic firm has an incentive to deviate. Finally, in case $i = H$ and $j = L$, depending on the value of t_{HL}, at least one firm has an incentive to deviate. A similar argument applies if $c_2 = c_H$. Thus we have the following result:

Proposition 4.1. *If both firms are asked for a report, the efficient tariffs t_H^* and t_L^* are implemented; moreover, auditing never takes place and hence does not cause any costs. Therefore, from the government's point of view, asking both firms for information is preferable to only relying on the domestic firm's report, provided that the fixed cost K of soliciting information from the foreign firm is sufficiently low.*

Compared to the case where the foreign firm is not asked to participate in the antidumping investigation, the equilibrium duties are optimal from the government's perspective, and no auditing costs are incurred. The only drawback of soliciting additional information from the foreign firm is the additional fixed cost K.

However, K may be such that it exceeds the expected sum of auditing costs and welfare loss from not implementing the efficient tariffs when relying only on the domestic firm's report. In this case, the government should refrain from soliciting information from the foreign firm and apply the procedure described in Section 3. Asking only one firm is more likely to be optimal if α is large and/or A is small, indicating that expected auditing costs are low and, therefore, the implemented tariffs do not strongly differ from the efficient ones when only the domestic firm reports.

4.2. **Conditional reporting of the foreign firm.** In the previous section, it was shown that when both firms are asked for a cost report, the government implements the efficient tariff scheme and never audits. Thus, compared to the first-best world where the government observes the foreign firm's cost, welfare is diminished only by the cost of soliciting and processing the additional information of the foreign firm, K. By contrast, in Section 3, we have seen that asking only the domestic firm for cost information results in a distortion of the tariff scheme and the occurrence of auditing cost. However, the government does not have to incur K. In this section, we answer the question whether a "hybrid" case may be superior. In such a hybrid case,

depending on the initial information obtained from the domestic firm, the government decides whether or not to also ask the foreign firm for information. This approach has the obvious advantage that K does not always have to be paid.

In particular, since a high-cost report of the domestic firm seems to be trustworthy as long as the tariff is decreasing in c_2, we propose the following mechanism: If the domestic firm's dumping complaint contains the information that costs are high, the government implements t_H^*. If, however, the domestic firm reports low cost, the government asks the foreign firm for complementary information. If the foreign firm confirms that $c_2 = c_L$, the tariff t_L^* is imposed; else, the government conducts an audit, followed by the implementation of $h_{LH} < t_H^*$ if it turns out that $c_2 = c_H$ and $l_{LH} > t_L^*$ otherwise. Finally, participation of the foreign firm is ensured by choosing a tariff $f \geq t_L^*$ in case of non-participation.

Solving this game by backwards induction, it is easily verified that truth-telling is the unique equilibrium. Consider the stage where the foreign firm is asked about its cost, implying that the domestic firm delivered a low-cost report. If $c_2 = c_L$, the foreign firm prefers to tell the truth to avoid a punishing tariff after an audit. If $c_2 = c_H$, the foreign firm contradicts the claim of the domestic firm to obtain a lower tariff. Given that the foreign firm will not misrepresent its cost, the domestic firm cannot benefit from lying in the first stage, either. This leads to the next result:

Proposition 4.2. *Consider the case when the antidumping authority only solicits additional information from the foreign firm if the domestic firm reports $c_2 = c_L$, but believes the domestic firm's report otherwise. Then, the full information tariffs t_H^* and t_L^* are implemented; auditing never takes place and hence does not cause any costs. Moreover, with probability α, i.e., the probability that $c_2 = c_H$, no costs of asking the foreign firm have to be incurred. Hence, this mechanism is preferable to the one where information is always solicited from both firms.*

Since this two-step procedure reduces the expected cost of collecting information from the foreign firm and at the same time also leads to zero auditing costs and implementation of the full information duties, it clearly dominates the mechanism where the authority always asks both firms. It thus also increases the threshold for

the fixed costs K above which the authority would, regardless of the domestic firm's cost report, never ask the foreign firm for information.

5. Imperfect Auditing

Thus far, we have assumed that conducting an audit is perfect in the sense that it always reveals the true cost. In this section, we extend our model to the case when auditing is imperfect. Suppose that, if a firm has lied and the government audits, it detects lying with probability τ, where $0 \leq \tau < 1$ ($\tau = 1$ corresponds to perfect auditing). With probability $1-\tau$, the government does not uncover a wrongful report. In Section 4, we have shown that the government prefers conditional reporting to always soliciting a report from the foreign firm. Therefore, we henceforth compare the conditional reporting procedure (scheme C) to the one where only the domestic firm's report is taken into account (scheme D).

We first need to specify scheme C more generally. If $i = H$, the tariff is t_H; if $i = L$, the foreign firm is asked for a report. If $j = L$, the tariff is t_{LL}; if $j = H$, the government conducts an audit with probability θ_{LH}. If there is no audit or the audit does not reveal which firm lied, the tariff is t_{LH}. If there is an audit and it turns out that $c_2 = c_H$, the tariff is h_{LH}; if there is an audit revealing $c_2 = c_L$, the tariff l_{LH} is imposed.

For the next result, recall that t_0 is the tariff at which the foreign firm shuts down production. We derive the following result, which is proven in Appendix A:

Proposition 5.1. *Suppose that auditing uncovers the foreign firm's true cost with probability $\tau \in [0, 1)$. Under scheme C, a necessary condition for t_H and t_{LL} to be feasible is that*

$$t_{LL} - t_H \leq \tau t_0. \tag{5.1}$$

Under scheme D, a necessary condition for t_H and t_L to be implementable is that

$$t_L - t_H \leq \tau t_L. \tag{5.2}$$

Proposition 5.1 shows that diminishing the effectiveness of the auditing process has a detrimental effect on both schemes. Under scheme C, although auditing never occurs in equilibrium, its potential ineffectiveness nevertheless intensifies incentives to

lie and thereby restricts the set of tariffs that can be implemented in a truth-telling equilibrium. In particular, by (5.1), if auditing is sufficiently unproductive, i.e., if $\tau t_0 < t_L^* - t_H^*$, the efficient tariffs are no longer implementable. Under scheme D, a decrease in τ means that, in case of an audit, a wrongful report is less likely to be detected. To sustain incentives for truth-telling, the government optimally decreases the tariff gap and raises the auditing probability.

Given that $t_L \leq t_0$, conditions (5.1) and (5.2) suggest that scheme C may still have a comparative advantage over D. Indeed, as the following result shows, scheme C is likely to be superior from the government's point of view.

Proposition 5.2. *Under imperfect auditing, the government still prefers scheme C to scheme D, provided that K is not too large.*

As we show in the proof of Proposition 5.2 in Appendix A, the set of feasible tariffs under scheme C includes all tariffs implementable under scheme D. Moreover, as in the case of perfect auditing, C does not cause any auditing cost. Thus, even though C may no longer lead to the implementation of the efficient tariff scheme, it still has the advantage of avoiding auditing cost.

6. Non-contractible Auditing

In the previous sections, we assumed that auditing probabilities are contractible. Contractibility requires that a third party is able to verify whether the government complied with an ex-ante announced random auditing procedure. Clearly, this is difficult to accomplish in practice. Sometimes it may even be difficult to assess whether an audit has been conducted at all. We therefore now discuss the situation where auditing cannot be contracted upon. For simplicity, we return to the assumption that auditing, if carried out, is perfect.

First, consider scheme C as defined in Section 4.2, under which auditing never occurs in equilibrium. Nevertheless, for the mechanism to work, it is crucial that the threat of audit be credible. That is, firms must believe that the authority will spend resources to learn c_2 whenever reports do not coincide. Since auditing is non-contractible, this will be the case only if an ex ante announced auditing procedure is self-enforcing, i.e., it is ex post in the government's best interest to stick to it. The

problem is that, since auditing is costly, the government may be better off by just implementing the tariff $\bar{t}$ that is optimal if the government does not elicit further information. This tariff maximizes $\alpha W(c_H, t) + (1-\alpha)W(c_L, t)$, and is thus

$$\bar{t} = \frac{a - [\alpha c_H + (1-\alpha)c_L]}{3}.$$

Proposition 6.1. *Auditing under scheme C is self-enforcing provided that*

$$\frac{\alpha(1-\alpha)(c_H - c_L)^2}{18b} > A. \tag{6.1}$$

To see this, note that in case reports $i = L$ and $j = H$ arrive, the government is strictly better off by conducting an audit if[8]

$$\alpha W(c_H, h_{LH}) + (1-\alpha)W(c_L, l_{LH}) - A > \alpha W(c_H, \bar{t}) + (1-\alpha)W(c_L, \bar{t}).$$

The left-hand side of this inequality is largest if h_{LH} and l_{LH} are just marginally below or above t_H^* and t_L^*, respectively. Substituting $h_{LH} = t_H^*$ and $l_{LH} = t_L^*$, the inequality simplifies to (6.1).

The threat of audit is thus more likely to be credible if α is close to 0.5, $c_H - c_L$ is large, and auditing costs A are small. Then, uncertainty about the foreign firm's cost is high so that the government strongly benefits from finding out the true cost parameter and tailoring the tariff to the actual situation. Thus, somewhat paradoxically, the government is able to implement efficient tariffs without any audits if the quality of ex ante information about c_2 is poor.

The threat of audits being self-enforcing does not depend on the auditing probability. To see this, assume that, in contrast to the previous considerations, the government announces an auditing probability $\theta_{LH} < 1$. In this case, if firms submit differing reports, a random procedure determines whether an audit is to be conducted or not. Whenever this procedure requires an audit to occur, the government has an incentive to audit only if (6.1) is satisfied.

If (6.1) does not hold, firms anticipate that there will never be an audit. Consequently, under every tariff scheme where $t_H \neq t_{LL}$, one firm always has an incentive to lie about c_2. The government is therefore not able to elicit information from firms when applying scheme C.

[8]Strict inequality of payoffs avoids multiple equilibria.

Alternatively, the government could employ scheme D as characterized in Section 3. However, under scheme D, credible commitment to auditing is even more difficult than under C. In the latter procedure, auditing is supposed to occur only if firms' reports differ and the government is thus unable to gather any additional information from them. An audit then indeed improves the government's information and, consequently, may be credible. In contrast, under scheme D, the government must audit with positive probability even if it is clear that, due to the incentive compatibility of the mechanism, the report is truthful. Since there is no immediate benefit from auditing, it is not self-enforcing.[9] This result can be summarized in the following proposition:

Proposition 6.2. *Auditing under scheme D is not self-enforcing.*

Thus, if condition (6.1) is not satisfied, the government just implements $\bar{t}$ if the domestic firm files a suit, without asking the foreign firm for a report. This approach can be interpreted as sticking to a "facts available" policy. Blonigen (2006) shows that this option is chosen increasingly often. Condition (6.1) suggests two possible explanations for this fact: (i) Because the number of dumping suits has increased over time, authorities may suffer from work overload so that A is high. As a consequence, they cannot credibly commit to a thorough audit. This in turn implies that it is not worthwhile to pay attention to firms' reports. Anticipating that there will be no serious audit, firms lie anyway.[10] (ii) Over time, authorities may have become more

[9]Self-enforcement could be achieved in a repeated game if the authority cares about its reputation in future dumping suits (possibly involving other firms if they can observe the government's behavior). If this is the case and the discounted expected benefit from sustaining a reputation for conducting audits exceeds A, the threat of audit is credible. However, since the expected benefit from conducting an audit equals the discounted welfare implemented in a one-shot game, scheme D cannot have a comparative advantage over scheme C in a repeated interaction as long as it is not superior in a one-shot game.

[10]This implies that, to implement efficient tariffs, the government may want to have an "oversized" agency dealing with dumping suits. In equilibrium, the agency's employees would be idle, but this signals that there exist sufficient resources to conduct audits. Or, in other words, the opportunity costs of an audit are very low.

experienced, i.e., they have better estimates about foreign firms' costs so that the left-hand side of (6.1) decreases.

7. Conclusion

In this paper, we investigate the domestic government's antidumping duty choice in an asymmetric information framework where the foreign firm's cost is observed by the domestic firm, but not by the government. Truthful cost revelation can be ensured by gathering additional information (auditing) conditional on firms' cost reports and threatening penalty duties in case untruthful reporting is detected.

The full-information (efficient) tariffs are implemented if the government also collects information from the foreign firm in case the domestic firm reports low cost (scheme C). If the government never solicits information from the foreign firm (scheme D), the efficient tariffs will not be implemented despite the fact that a mechanism can be designed such that the domestic firm will always tell the truth in equilibrium. If no audit occurs, this can be viewed as a "facts available" policy because no additional information is gathered after the domestic firm has filed a dumping complaint. Such a scheme may be optimal if the welfare losses from implementing non-efficient tariffs and/or auditing costs are low or if the costs of obtaining information from the foreign firm are high.

If the government cannot commit to auditing ex post, scheme D does not work because it is not ex post optimal for the government to conduct an audit. In contrast, auditing under scheme C may be self-enforcing, but if the auditing cost is too large or ex-ante information about foreign cost is too precise, auditing is not contractible, either. Then, the government will be better off by disregarding the firm reports and only using ex ante available information, which constitutes another case of a "facts available" policy.

Acknowledgements

We are grateful to Per Fredriksson, Paul Pecorino, Gautam Tripathi, and seminar participants at the University of Connecticut for helpful comments. Anja Schöttner thanks the German Academic Exchange Service (DAAD) for a fellowship supporting her research.

Appendix A. Proofs

Proof of Proposition 3.1. Letting μ denote the Lagrange multiplier for (3.2), the first-order condition for an interior solution with $0 < \theta_L < 1$ is

$$-(1-\alpha)A + \mu[\Pi_1(c_H, t_L) - \Pi_1(c_H, 0)] = 0.$$

It follows that, if $t_L > 0$ (which will be the case at the optimal solution) and $0 < \theta_L < 1$, then $\mu \neq 0$ and thus (3.2) must be binding. Concerning possible corner solutions, note that $\theta_L = 1$ can only be optimal if $t_H = 0$. Then, (3.2) is also binding. Furthermore, $\theta_L = 0$ is feasible and thus optimal only if $t_H \geq t_L$. If $t_H = t_L$, (3.2) is again binding. A tariff schedule with $t_H > t_L$ cannot be optimal. In this case, we would have $t_H \neq t_H^*$, or $t_L \neq t_L^*$, or both, while (3.2) is not binding. Thus, the government can increase its expected profit by marginally adjusting t_H or t_L, keeping $\theta_H = 0$. Consequently, (3.2) is always binding at the optimal solution yielding

$$\theta_L(t_H, t_L) = \frac{\Pi_1(c_H, t_L) - \Pi_1(c_H, t_H)}{\Pi_1(c_H, t_L) - \Pi_1(c_H, 0)}. \tag{A.1}$$

Note that $\theta_L \in [0, 1]$ for $t_H \geq 0$, which will be the case at the optimal solution. Using (A.1), we can substitute θ_L in the objective function to obtain

$$\max_{t_L, t_H}\{\alpha W(c_H, t_H) + (1-\alpha)[W(c_L, t_L) - \theta_L(t_H, t_L)A]\}. \tag{A.2}$$

The first-order conditions with respect to t_H and t_L then are[11]

$$\alpha\frac{a - c_H - 3t_H}{3b} - (1-\alpha)\frac{\partial\theta_L}{\partial t_H}A = 0, \tag{A.3}$$

$$\frac{a - c_L - 3t_L}{3b} - \frac{\partial\theta_L}{\partial t_L}A = 0. \tag{A.4}$$

From these conditions, since $\frac{\partial\theta_L}{\partial t_H} < 0$ and $\frac{\partial\theta_L}{\partial t_L} > 0$, it follows that $t_H^* \leq t_H$ and $t_L \leq t_L^*$ (the inequalities are binding if $A = 0$). Finally, it remains to verify that this solution also satisfies (3.1b). But, provided the antidumping authority sets $f_L \leq t_L$, this follows immediately from the fact that $t_L \geq t_H$. □

[11] We assume that the first-order conditions are also sufficient, which is the case if b is sufficiently small.

Proof of Proposition 5.1. Under scheme D, the domestic firm's incentive compatibility constraint for the case $c_2 = c_H$ now is

$$\Pi_1(c_H, t_H) \geq (1 - \tau\theta_L)\Pi_1(c_H, t_L) + \tau\theta_L\Pi_1(c_H, f_H). \tag{A.5}$$

The government cannot do better than setting $f_H = 0$. Then, due to the convexity of $\Pi_1(c_2, t)$ in t, for (A.5) to hold it is necessary that

$$t_H \geq (1 - \tau\theta_L)t_L,$$

which is equivalent to $t_L - t_H \leq \tau\theta_L t_L$. Applying $\theta_L \leq 1$, inequality (5.2) follows immediately. Furthermore, it is easily verified that the first-order conditions characterizing the optimal tariffs, using the fact that θ_L is equal to the expression given in (A.1) divided by τ, now are

$$\alpha\frac{a - c_H - 3t_H}{3b} + (1 - \alpha)\frac{\partial\theta_L}{\partial t_H}A = 0,$$
$$\frac{a - c_L - 3t_L}{3b} - \frac{\partial\theta_L}{\partial t_L}A = 0.$$

Implicit differentiation of these conditions yields that t_H decreases in τ whereas t_L increases. To prove (5.1), we need to derive the incentive compatibility constraints for scheme C. To do so, we first consider the second stage of the game, where the foreign firm is asked for a report. If $c_2 = c_L$, truthful reporting requires that

$$\Pi_2(c_L, t_{LL}) \geq (1 - \tau\theta_{LH})\Pi_2(c_L, t_{LH}) + \tau\theta_{LH}\Pi_2(c_L, l_{LH}). \tag{A.6}$$

If $c_2 = c_H$, the only way that the game could have progressed to the second stage is that firm 1 must have reported $c_2 = c_L$, so that firm 2's incentive compatibility constraint is

$$(1 - \tau\theta_{LH})\Pi_2(c_H, t_{LH}) + \tau\theta_{LH}\Pi_2(c_H, h_{LH}) \geq \Pi_2(c_H, t_{LL}). \tag{A.7}$$

In the first stage, given truthful reporting in stage two, the home firm's incentive compatibility constraints for $c_2 = c_L$ and $c_2 = c_H$, respectively, are

$$\begin{aligned} \Pi_1(c_L, t_{LL}) &\geq \Pi_1(c_L, t_H), \\ \Pi_1(c_H, t_H) &\geq (1 - \tau\theta_{LH})\Pi_1(c_H, t_{LH}) + \tau\theta_{LH}\Pi_1(c_H, h_{LH}). \end{aligned} \tag{A.8}$$

To satisfy (A.6), (A.7), and (A.8), the government cannot do better than choosing l_{LH} such that $\Pi_2(c_L, l_{LH}) = 0$ and $h_{LH} = 0$. Then, by convexity of $t \mapsto \Pi_i(c_2, t)$ for each i, in order for (A.6) and (A.8) to be satisfied it is necessary that

$$t_{LL} \leq (1 - \tau\theta_{LH})t_{LH} + \tau\theta_{LH}t_0,$$
$$t_H \geq (1 - \tau\theta_{LH})t_{LH}.$$

Combining these two conditions and then using that $\theta_{LH} \leq 1$, we obtain that t_{LL} and t_H are implementable only if (5.1) holds. □

Proof of Proposition 5.2. Under scheme D, the firm's incentive compatibility constraints now are

$$\Pi_1(c_H, t_H) \geq (1 - \tau\theta_L)\Pi_1(c_H, t_L) + \tau\theta_L\Pi_1(c_H, f_H), \tag{A.9a}$$
$$\Pi_1(c_L, t_L) \geq (1 - \tau\theta_H)\Pi_1(c_L, t_H) + \tau\theta_H\Pi_1(c_L, f_L). \tag{A.9b}$$

We now show that any combination of tariffs t_H and t_L with $t_H \leq t_L$ that is feasible under scheme D is also implementable under scheme C. Consider the particular tariffs $t_H = \hat{t}_H$, $t_L = \hat{t}_L$, and $\hat{t}_H \leq \hat{t}_L$, and assume that these tariffs satisfy (A.9a) and (A.9b) for some auditing probabilities θ_L and θ_H and $f_L = f_H = 0$. Then, it must also hold that

$$\Pi_1(c_H, \hat{t}_H) \geq (1 - \tau)\Pi_1(c_H, \hat{t}_L) + \tau\Pi_1(c_H, 0). \tag{A.10}$$

Regarding scheme C, set $\theta_{LH} = 1$, $t_H = \hat{t}_H$, $t_{LL} = t_{LH} = \hat{t}_L$, $h_{LH} = 0$, and $l_{LH} = t_0$, such that $\Pi_2(c_L, l_{LH}) = 0$. Then, it is easily verified that (A.6)–(A.8) are satisfied. In particular, (A.8) follows from (A.10). Thus, by applying scheme C, the government can implement at least the set of tariffs that is feasible under D. Moreover, to implement these tariffs, it does not have to incur any auditing costs. Therefore, C is still preferable provided that K is not too large. □

Appendix B. Additional calculations

Concavity of (A.2). The partial derivatives of the government's objective function, denoted by Γ, are:

$$\frac{\partial^2\Gamma}{\partial t_H^2} = -\frac{\alpha}{b} - (1-\alpha)\frac{\partial^2\theta_L}{\partial t_H^2}A,$$
$$\frac{\partial^2\Gamma}{\partial t_L^2} = (1-\alpha)\left[-\frac{1}{b} - \frac{\partial^2\theta_L}{\partial t_L^2}A\right],$$
$$\frac{\partial^2\Gamma}{\partial t_L \partial t_H} = -(1-\alpha)\frac{\partial^2\theta_L}{\partial t_L \partial t_H}A.$$

For concavity of (A.2), it must hold that

$$\frac{\partial^2\Gamma}{\partial t_H^2} < 0,\ \frac{\partial^2\Gamma}{\partial t_L^2} < 0,\ \frac{\partial^2\Gamma}{\partial t_H^2}\frac{\partial^2\Gamma}{\partial t_L^2} - \left(\frac{\partial^2\Gamma}{\partial t_L \partial t_H}\right)^2 > 0.$$

First note that $\theta_L(t_H, t_L)$ is independent of b since this parameter cancels out when calculating the profit function quotient. Calculating the derivatives yields:

$$\frac{\partial\theta_L}{\partial t_H} = -\frac{\frac{\partial\Pi_1(c_H,t_H)}{\partial t_H}}{\Pi_1(c_H,t_L) - \Pi_1(c_H,0)} < 0, \tag{B.1}$$
$$\frac{\partial^2\theta_L}{\partial t_H^2} = -\frac{\frac{\partial^2\Pi_1(c_H,t_H)}{\partial t_H^2}}{\Pi_1(c_H,t_L) - \Pi_1(c_H,0)} < 0,$$
$$\frac{\partial^2\theta_L}{\partial t_L \partial t_H} = \frac{\frac{\partial\Pi_1(c_H,t_L)}{\partial t_L}\frac{\partial\Pi_1(c_H,t_H)}{\partial t_H}}{[\Pi_1(c_H,t_L) - \Pi_1(c_H,0)]^2} > 0,$$
$$\frac{\partial\theta_L}{\partial t_L} = \frac{\frac{\partial\Pi_1(c_H,t_L)}{\partial t_L}[\Pi_1(c_H,t_H) - \Pi_1(c_H,0)]}{(\Pi_1(c_H,t_L) - \Pi_1(c_H,0))^2} > 0 \tag{B.2}$$
$$\frac{\partial^2\theta_L}{\partial t_L^2} = -\frac{2t_H[2(a-2c_1+c_H)+t_H][4(a-2c_1+c_H)^2 + 6(a-2c_1+c_H)t_L + 3t_L^2]}{t_L^3[2(a-2c_1+c_H)+t_L]^3} < 0.$$

The last derivative is negative which follows from the fact that $a - 2c_1 + c_H \geq 0$ since we assume that $q_1(0) > 0$ (see Section 2). Thus, (A.2) is concave in the relevant range[12] $0 < t_H^* \leq t_H \leq t_L \leq t_L^*$ for sufficiently small b, since the second derivatives of θ_L are bounded over this range. □

[12]By the first-order conditions (A.3) and (A.4), the candidate solution for a global maximum lies within this range. Moreover, when deriving the optimal tariff combination, we could also restrict attention to the range $t_H^* \leq t_H \leq t_L \leq t_L^*$ from the outset. On the one hand, for any given t_L, (A.2) increases in t_H if $t_H < t_H^*$. The reason is that raising t_H improves welfare while lowering the optimal

Proof that $t_L - t_H$ decreases in A. By the first-order conditions (A.3) and (A.4),

$$\begin{bmatrix} -\frac{\alpha}{b} - (1-\alpha)\frac{\partial^2\theta_L}{\partial t_H^2}A & -(1-\alpha)\frac{\partial^2\theta_L}{\partial t_H \partial t_L}A \\ -\frac{\partial^2\theta_L}{\partial t_H \partial t_L}A & -\frac{1}{b} - \frac{\partial^2\theta_L}{\partial t_L^2}A \end{bmatrix} \begin{bmatrix} \frac{\partial t_H}{\partial A} \\ \frac{\partial t_L}{\partial A} \end{bmatrix} = \begin{bmatrix} (1-\alpha)\frac{\partial\theta_L}{\partial t_H} \\ \frac{\partial\theta_L}{\partial t_L} \end{bmatrix}.$$

Denoting the 2×2-matrix by H and applying Cramer's rule yields

$$\frac{\partial t_H}{\partial A} = \frac{\det \begin{bmatrix} (1-\alpha)\frac{\partial\theta_L}{\partial t_H} & -(1-\alpha)\frac{\partial^2\theta_L}{\partial t_H \partial t_L}A \\ \frac{\partial\theta_L}{\partial t_L} & -\frac{1}{b} - \frac{\partial^2\theta_L}{\partial t_L^2}A \end{bmatrix}}{\det H},$$

$$\frac{\partial t_L}{\partial A} = \frac{\det \begin{bmatrix} -\frac{\alpha}{b} - (1-\alpha)\frac{\partial^2\theta_L}{\partial t_H^2}A & (1-\alpha)\frac{\partial\theta_L}{\partial t_H} \\ -\frac{\partial^2\theta_L}{\partial t_H \partial t_L}A & \frac{\partial\theta_L}{\partial t_L} \end{bmatrix}}{\det H}.$$

Since the government's objective function is concave, it must hold that

$$\det H > 0, \ -\frac{1}{b} - \frac{\partial^2\theta_L}{\partial t_L^2}A < 0, \ -\frac{\alpha}{b} - (1-\alpha)\frac{\partial^2\theta_L}{\partial t_H^2}A < 0.$$

Together with $\frac{\partial\theta_L}{\partial t_H} < 0$, $\frac{\partial\theta_L}{\partial t_L} > 0$, and $\frac{\partial^2\theta_L}{\partial t_H \partial t_L} > 0$, compare (B.1) and (B.2), we get

$$\frac{\partial t_H}{\partial A} > 0 \quad \text{and} \quad \frac{\partial t_L}{\partial A} < 0. \qquad \square$$

Proof that $t_L - t_H$ increases in α. From the above considerations,

$$\frac{\partial t_H}{\partial \alpha} = \frac{\det \begin{bmatrix} \frac{a-c_H-3t_H}{3b} + \frac{\partial\theta_L}{\partial t_H}A & -(1-\alpha)\frac{\partial^2\theta_L}{\partial t_H \partial t_L}A \\ 0 & -\frac{1}{b} - \frac{\partial^2\theta_L}{\partial t_L^2}A \end{bmatrix}}{\det H} < 0,$$

$$\frac{\partial t_L}{\partial \alpha} = \frac{\det \begin{bmatrix} -\frac{\alpha}{b} - (1-\alpha)\frac{\partial^2\theta_L}{\partial t_H^2}A & \frac{a-c_H-3t_H}{3b} + \frac{\partial\theta_L}{\partial t_H}A \\ -\frac{\partial^2\theta_L}{\partial t_H \partial t_L}A & 0 \end{bmatrix}}{\det H} > 0. \qquad \square$$

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auditing probability. On the other hand, for any given t_H, lowering t_L improves the government's objective function if $t_L > t_L^*$.

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Department of Economics, University of Connecticut, Storrs, CT-06269, USA.
E-mail address: xenia.matschke@uconn.edu

Department of Economics, BWL II, University of Bonn, Adenauerallee 24-42, D-53113 Bonn, Germany.
E-mail address: anja.schoettner@uni-bonn.de