On the Role of Retaliation in Trade Agreements*

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Abstract

The goal of the current paper is to analyze the role of retaliation in trade agreements. Its main result consists in showing that, in the presence of private information, retaliation can always be used to increase the value of such agreements for the participating governments. Moreover, we show that retaliation is a necessary feature of any efficient equilibrium.

We argue that retaliation would not be necessary if countries could resort to transfers or export subsidies: in either case, terms-of-trade externalities can be internalized and efficiency can be achieved at each point in time. In reality, though, transfers are seldom observed whereas subsidies are prohibited, so that the use of the remaining trade instruments in a retaliatory fashion might very well be optimal. The model is used to interpret the increase in the retaliatory use of antidumping measure observed over the last decades.

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1 Introduction

The goal of the current paper is to analyze the role of retaliation in trade agreements. Its main result consists in showing that, in the presence of private information, retaliation can always be used to increase the value of such agreements for the participating governments. Moreover, retaliation is a necessary feature of any efficient equilibrium.

We study a two good, two country model of trade in which countries interact repeatedly. It is assumed that the preferences of governments are subject to random shocks that affect their relative valuation of the import competing sector. Although we interpret these shocks as stemming from changes in the political pressure for protection, alternative interpretations such as shifting production externalities would not be inconsistent with our moder. In our setup, it is in principle be optimal for governments to raise their import tariffs when their valuation of the import competing sector is high, and to decrease them otherwise.

It is assumed, however, that governments cannot observe the preferences of their trading partner. This feature gives rise to a problem of incentive compatibility: since governments always have an incentive to set relatively high tariffs in order to affect the terms of trade in their favor, they will have a tendency to overstate their preference for protection at any point in time. To prevent them from doing so, there must be some cost associated to the use of high tariffs.

This paper analyzes different ways in which such a cost can be imposed, and concludes that - when governments only have access to import tariffs - some retaliation is always desirable. We first consider a basic scenario in which countries can resort to direct transfers or to export subsidies. In both of these cases, governments can be encouraged to tell the truth without sacrificing any efficiency. The reason is that, when these instruments are available, the terms of trade gains associated to any given tariff level can be offset through payments to the other country or through adjustments in the latter´s level of export subsidies. However, since compensating transfers are not observed in the world and the use of export subsidies is restricted under GATT/WTO, we then shift our attention to the more realistic environment in which none of these policy instruments are available.

In such a scenario, the only trade policy instrument that governments control at any point in time are import tariffs. Thus, if governments are to be truthful about their preference for protection, higher tariffs from any one of them must be associated to a cost in the form of higher tariffs from their trading partner. These higher tariffs from their trading partner, in turn, can take place either contemporaneously or be delayed into the future. We refer to the former situation, evocative of the reciprocal tariff withdrawal scheme allowed under GATT, as one of reciprocity. The latter

possibility, in turn, is referred to as retaliation.

Our main results are that; any equilibrium that is based on reciprocity can be outperformed by an alternative equilibrium that is based on retaliation and that; retaliation is a necessary feature of any efficient equilibrium.

The intuition for the first result is as follows: in an equilibrium based on reciprocity, incentive compatibility stems from the fact that each country's tariffs are directly related to those of their trading partners. Hence, tariffs are never set at their efficient levels, since each period they are jointly used to accommodate governments' shifting preferences for protection and to provide incentives for truthtelling. Suppose instead an alternative equilibrium in which countries simply set their tariffs at the efficient level. In such a scenario, incentive compatibility is achieved by making higher tariffs by any one country today increase the probability of punishment tomorrow in the form of a higher average tariff from its trading partner. In the event that it is punished, then, a country receives a lower payoff than the punishing country. The payoff of governments in such an equilibrium, which will be a linear combination of the efficent payoffs and the expected payoffs from the punishment phases, is shown to always be higher than the payoffs attainable under reciprocity.

We then show that, in order to reach (approximately) efficient cooperation, retaliation must occur on the equilibrium path. Our result is an application of the theoretical findings of Fudenberg et al. (1994), who proved that efficient cooperation is possible in a class of repeated games with private information. In our model, efficient cooperation requires truthtelling, which in turn can only arise if high tariffs today lead to lower payoffs tomorrow. Truthtelling, however, is by itself not enough. It is also necessary that truthtelling is induced without sacrificing future welfare. This can only be achieved by aligning incentives through the redistribution of future welfare among countries, while preserving the level of joint welfare intact. But this means that whenever a country's expected welfare from cooperation decreases, that of the other country must increase, implying that there must be retaliation in equilibrium.

Having shown this result, we then ask whether retaliation is actually being observed within the WTO trading system. We find at least one instance where this seems to be the case: antidumping (henceforth, AD) measures. The use of AD measures has increased significantly over the last two decades, and so has the number of countries using them. Moreover, there is a increasing body of empirical evidence suggestive of the fact that AD measures are not being used to counter the existence of dumping, but rather in a strategic or retaliatory fashion. Prusa and Skeath [27], for example, analyze the trends in worldwide AD filings during the past two decades. They conclude that about 50% of all AD filings are consistent with a retaliatory motive, meaning that countries tend to use this instrument against those who have used it against them in the past. Adopting a

different approach by which they focus more on industry filing decisions, Blonigen and Bown [11] find evidence suggesting that the use of AD is affected by the threat of retaliation through the same channel. In particular, they find that industries seem less likely to initiate petitions against firms from countries which have active AD provisions and are at the same time an important destination for their exports. Finger and Feinberg and Olson provide additional evidence in favor of the retaliatory use of AD.

This mounting evidence regarding the strategic or retaliatory use of antidumping has led many to argue in favor of eliminating this policy tool altogether. To illustrate these opinions we can mention Klitgaard and Schiele [20], who criticize both the theory behind AD regulations and the way in which they are applied. Regarding the former, they consider the concept of dumping itself to be seriously flawed from an economic perspective, while they also question the procedures used to review dumping allegations. In a similar spirit, Barfield [6] argues that AD measures are "fundamentally at odds with the free trade policies that have dramatically increased global welfare over the last half century."[1]

Our model suggests a different view, by which - as countries joint the WTO system and in so doing lose some of their policy instruments - the retaliatory use of the remaining ones might be an efficient way to accomodate shocks to preferences. Our underlying argument is thus conceptually very simple: once governments are refrained from freely using all their instruments, it might well be that a retaliatory use of the remaining ones enhances the value of cooperation. Note how this notion is reminiscent of Tinbergen's work (Tinbergen (1967)), which we believe is particularly useful to interpret our results. In designing rules for international cooperation, it must be considered that the elimination of some instruments which are normally available to governments might trigger the use of the remaining ones in new and unforeseen ways. In our particular setup, this is exactly the case of retaliation, which may increase the value of trade agreements when the use of other instruments is restricted but the objectives to be attained remain unchanged.

Our model displays interesting characteristics at different levels. In the first place, it analyzes retaliation within the context of strategic interaction between governments (henceforth, "strategic trade framework"). The latter framework has been increasingly useful in understanding the role of the world trade system and its particular regulations, and our analysis of retaliation is compatible with existing research in this direction. Second, the modeling strategy is relatively new within the aforementioned framework itself, which has not yet fully developed the potential of repeated games

[1] Barfield's critiques of AD refer mostly to its use in high-tech sectors, which may have some particular characteristics that our model does not address.

of private information.[2] Our paper tries to do so while hopefully yielding some insights on the role of retaliation in trade agreements.

Within the trade literature, our paper is most closely related to the work of Bagwell and Staiger [7], Feenstra and Lewis [13] and Riezmann. The former deals with a repeated setting very similar to ours, but in which there is no private information: thus, the equilibrium strategies are not subject to the additional constraint of inducing truthtelling, and must only guarantee that governments have no incentives to openly abandon cooperation. Since these incentives fluctuate with the economic environment, so does the level of cooperation that is sustainable at equilibrium. Feenstra and Lewis, on the other hand, deal with a static setting in which - at the moment of negotiating trade restrictions - one government has private information regarding the political pressure it faces from domestic producers. Although similar in spirit, our approach differs from theirs in two ways. The first and most important difference is that they assume that governments behave in a cooperative manner: our setting is noncooperative and the behavior of governments is obtained as an equilibrium to a game of repeated interaction. A second difference is that they assume one-sided private information, whereas we analyze a game in which both governments have private information regarding their domestic environment. Riezmann (1991), on the other hand, builds on the work of Green and Porter (1984) on repeated Cournot competition in order to analyze a repeated tariff game with private information. His analysis though, is restricted to symmetric trade wars, in which high tariffs from any one country can lead to lower future payoffs for all countries. By not allowing for future payoffs to be distributed in an asymmetric fashion between countries, cooperation is bounded away from optimality in his setting.

The structure of the paper is as follows: we first present the static game in Section 2 and briefly comment on its properties. Section 3 explains the basic setup and notation of the repeated game. In Section 4, equilibria of the latter are analyzed under the assumption that governments can resort to more than one instrument: in particular, we show how the model allows for efficient equilibria in the presence of transfers or export subsidies. Section 5 concentrates on the repeated game when import tariffs are the only instruments that governments can use, and it contains our main results regarding the welfare enhancing role of retaliation. Finally, Section 6 provides an example by analyzing the recent evolution in the use of AD measures and concludes.

[2] Although for different purposes, Lee [21] also analyzes issues of international trade policy within a repeated framework of private information.

2 The Static Model

2.1 Basic Setup

This section lays the foundations of the simple two country, two good model that will be used throughout the paper, which draws heavily on Bagwell and Staiger [9]. Suppose there are two countries, which we call home and foreign, that trade two competitively-produced goods, x and y. Each of these goods is demanded in both countries according to a symmetric demand function D, and we assume x (y) to be the natural import good of the home (foreign) country. Let p_i represent the domestic price of good $i = x, y$ in the home country and let the domestic demand and supply functions for good i be represented by the linear functions $D(p_i)$ and $Q_i(p_i)$, respectively. In particular, we assume that $D(p_i) = \alpha - \beta p_i$, $Q_x(p_x) = \gamma p_x$ and $Q_y(p_y) = \phi p_y$. Analogously, we denote foreign demand and supply functions by $D(p_i^*) = \alpha - \beta p_i^*$, $Q_y^*(p_y^*) = \gamma p_y^*$ and $Q_x^*(p_x^*) = \phi p_x^*$. It is assumed that $\gamma < \phi$ in order to capture the fact that x is the natural import good of home. In the present model, countries are free to choose import tariffs and export subsidies, denoted by τ_x and τ_y in the case of home. The import tariff and export subsidy of foreign are denoted respectively by τ_y^* and τ_x^*.[3]

The market equilibrium of the static model is easily characterized, for given levels of import tariffs and export subsidies. Consider first the market for good x. For any given domestic price, home has an import function of

$$M_x = \alpha - (\beta + \gamma)p_x, \tag{1}$$

On the other hand, the export function of foreign is given by,

$$E_x^* = (\phi + \beta)p_x^* - \alpha. \tag{2}$$

Note also that, if we define p_x^w to be the world price of good x, it must be the case that $p_x = p_x^w + \tau_x$, while $p_x^* = p_x^w + \tau_x^*$. Thus, replacing these expressions in (1) and (2) and solving for the value of p_x^w that equals world imports and exports of good x, we obtain that

$$p_x^w = \frac{2\alpha - (\beta + \gamma)\tau_x - (\phi + \beta)\tau_x^*}{2\beta + \gamma + \phi}. \tag{3}$$

[3] As a convention, we let $\tau_j > 0$ denote a positive level of tariff (subsidy) levied on the import (export) good j.

Hence

$$p_x = p_x^w + \tau_x = \frac{2\alpha + (\beta+\phi)\tau_x - (\phi+\beta)\tau_x^*}{2\beta+\gamma+\phi}, \quad (4)$$

$$p_x^* = p_x^w + \tau_x^* = \frac{2\alpha - (\beta+\gamma)\tau_x + (\gamma+\beta)\tau_x^*}{2\beta+\gamma+\phi}. \quad (5)$$

The equilibrium conditions for market y are defined in an analogous manner.

2.2 Trade Policy

As can be seen from equations (3), (4) and (5), trade policy will affect the equilibrium prices and the volumes of trade in the markets for both goods. The present section characterizes government objectives and analyzes the equilibrium trade policies in the static model under symmetric and asymmetric information, while comparing them to the first-best choices.

It is assumed that each government's preferences are influenced by a political economy parameter, ζ (ζ^*), which affects its valuation of the import-competing sector. This parameter is assumed to be drawn randomly and independently in each period and is assumed to be uniformly distributed over a common support $\bar{\zeta} = \{\zeta_1, \zeta_2, ..., \zeta_N\}$, where $\zeta_1 < \zeta_2 < ... < \zeta_N$. We will first assume that governments can observe each other's political parameter and will later solve the static game under the assumption of private information.

We assume that governments maximize the sum of tariff revenues, consumer surplus and producer's surplus in each of the markets: in the case of the import good, the valuation given to the latter is adjusted by the political economy parameter.[4] Thus, the objective function of the home government can be expressed as,

$$W(p_x, p_y, p_x^w, p_y^w) = W_x(p_x, p_x^w) + W_y(p_y, p_y^w),$$

where W_x and W_y represent welfare derived from the x and y markets, respectively. These are in turn defined by

$$W_x(p_x, p_x^w) = \int_{\hat{p}_x}^{\frac{\alpha}{\beta}} D_x dp_x + \zeta\lambda_x(p_x) + [p_x - p_x^w]M_x,$$

$$W_y(p_y, p_y^w) = \int_{\hat{p}_y}^{\frac{\alpha}{\beta}} D_y dp_y + \lambda_y(p_y) - [p_y - p_y^w]E_y,$$

[4] Thus, we follow Baldwin [10] in interpreting the weights on producer surplus that exceed unity as representing domestic political economy forces.

where $\lambda_x(p_x)$ and $\lambda_y(p_y)$ denote the profits of home producers of goods x and y as functions of domestic prices, respectively, and - as was said earlier - ζ represents the political economy parameter. Note that the welfare functions as expressed above depend solely on the world and domestic prices of both goods and, ultimately, in the values of home and foreign's import tariffs and export subsidies. In the case of the foreign government, its welfare functions are analogous to the ones depicted above with the difference that the corresponding political economy parameter (ζ^*) affects the weight given to producers of good y.

Let us first analyze the stage game under symmetric information. In such a case, both governments observe each other's political parameter and then simultaneously set their tariffs and subsidies, so as to unilaterally maximize their welfare. In other words, for given values of ζ and ζ^*, home chooses τ_x and τ_y so as to solve

$$\max_{\tau_x, \tau_y} \quad W(p_x, p_y, p_x^w, p_y^w), \tag{6}$$

while foreign chooses τ_x^* and τ_y^* in order to solve an analogous problem. From (6) we can derive home's best response functions, which must satisfy the first order conditions

$$W_{p_x^w}\frac{\partial p_x^w}{\partial \tau_x} + W_{p_x}\frac{\partial p_x}{\partial \tau_x} = 0, \tag{7}$$

$$W_{p_y^w}\frac{\partial p_y^w}{\partial \tau_y} + W_{p_y}\frac{\partial p_y}{\partial \tau_y} = 0. \tag{8}$$

These conditions reflect the well-known fact that trade policy influences welfare through its impact on the terms of trade and on domestic prices. For the importing government, an increase in tariffs has the following effects: it increases the domestic price of the good, redistributing wealth from consumers to producers while inducing a welfare loss, and it has a favorable effect on the terms of trade. The higher the political economy parameter, the higher is the positive weight given to the redistributive effect and the higher will be the desired tariffs.

The Nash equilibria of the present model have been studied at length in the literature and are well understood.[5] In order to assess their properties in terms of efficiency, however, let us first characterize the properties of efficient tariffs.

Note that, in order for pairs of tariffs (τ_x, τ_x^*) and (τ_y, τ_y^*) to be efficient, it must be the case that they maximize the sum of home and foreign's welfare, i.e., they must be a solution to the following maximization problem:

[5] See, for example, Bagwell and Staiger [9].

$$\max_{\tau_x, \tau_x^*} \quad W_x(p_x, p_x^w) + W_x^*(p_x^*, p_x^w), \tag{9}$$

$$\max_{\tau_y, \tau_y^*} \quad W_y(p_y, p_y^w) + W_y^*(p_y^*, p_y^w). \tag{10}$$

It is straightforward to show from (9) and (10), as Bagwell and Staiger have done, that in the present model aggregate welfare depends only on the net tariffs in each market, i.e. on $\tau_x - \tau_x^*$ and $\tau_y - \tau_y^*$, while the precise values of the tariffs and subsidies determine the way in which total welfare is distributed among governments. More precisely, we use a particular pair of efficient tariffs and subsidies as our benchmark, which we call "politically optimal" tariffs, denoted by τ_x^{PO} and τ_x^{*PO}, and implicitly defined by the following first order conditions,

$$W_{p_x} \frac{\partial p_x}{\partial \tau_x} = 0, \tag{11}$$

$$W_{p_x^*}^* \frac{\partial p_x^*}{\partial \tau_x^*} = 0. \tag{12}$$

Thus, politically optimal tariffs are defined as the tariffs (and subsidies) that governments would choose if they internalized the externality generated by the terms of trade effect, being therefore lower (higher) than their Nash counterparts obtained from (7) and (8).

Due to the lack of political economy considerations in the export market, the politically optimal export subsidy in the present model is always zero. Regarding the import market, on the other hand, the politically optimal tariff will be strictly positive for all values of $\zeta > 1$, and it will be increasing in ζ. Thus, the net tariff that arises from governments choosing their politically optimal tariffs and subsidies is simply $\tau_x^{PO}(\zeta)$, and all combinations (τ_x, τ_x^*) for which $\tau_x^{PO}(\zeta) = \tau_x - \tau_x^*$ deliver the same total welfare.

Before proceeding, it is worthwhile at this point to highlight one characteristic of welfare functions in our model. Since they depend directly on world and local prices, which are in turn determined solely by tariffs and subsidies, welfare of home and foreign is ultimately a function of the latter and can therefore be expressed indirectly in those terms. This is the approach we take throughout the rest of the paper, and we therefore briefly state the properties of welfare functions so expressed. We can write the welfare of home's government as $W(\tau, \tau^*, \zeta)$, where $\tau = (\tau_x, \tau_y)$ and $\tau^* = \left(\tau_x^*, \tau_y^*\right)$. The support for ζ is chosen so that W is twice continuously differentiable with

respect to τ and τ^*.[6]

Since we will always use politically optimal tariffs as our benchmark, we will mostly be concerned with efficient tariffs that lie below the reaction function (below the Nash-tariffs) and for these we have that welfare is increasing in the import tariff, $\frac{\partial W}{\partial \tau_x} > 0$, decreasing in the export subsidy, $\frac{\partial W}{\partial \tau_y} < 0$ and strictly concave in τ_x ; $\frac{\partial^2 W}{\partial \tau_x^2} < 0$. Also, it is always the case that $\frac{\partial W}{\partial \tau_x}$ is higher for higher levels of ζ. Obviously, because of symmetry, the same assumptions and results hold for foreign.

Finally, it must be taken into account that the model presents a continuum of Nash equilibria in which there is no international trade: to see this, imagine a situation in which import tariffs (export subsidies) are set so high (low) as to individually eliminate the exchange of goods between both governments. Any such situation is clearly a Nash equilibrium, since no country can induce trade by unilaterally lowering (raising) its tariff (subsidy). The following remark, which is taken directly from Bagwell and Staiger, summarizes the discussion on the static model with symmetric information.

Remark 1. *In the static tariff game with symmetric information,*

1. *There exists a unique Nash equilibrium with positive trade volume (this follows from the strict concavity of the welfare function).*

2. *In the aforementioned equilibrium, the Nash import tariff is positive while the Nash export subsidy is negative, and all tariffs are higher than their political optimal values.*

3. *There also exists a continuum of autarky Nash equilibria.*

The previous remark highlights a well known result of the strategic trade literature, by which Nash tariffs are inefficient due to governments' desire to overexploit them in order to affect the terms of trade in their favor. In this sense, both governments could benefit from a reciprocal reduction of their tariffs, since such a change could leave the terms of trade constant while reducing everyone's domestic prices.

Since in the present paper we are interested in the case of asymmetric information, we now briefly analyze the static model for the case in which governments cannot observe each other's political preferences. In this case, the game is assumed to be as follows: governments learn their 'types' at the beginning of each period, after which they set their tariffs and subsidies in a simultaneous fashion and trade takes place.

[6] The support of ζ is relevant for this because, if the possible values of the parameter are too far apart, there are efficient equilibria with no trade: at this point, then, W would clearly not be twice continuously differentiable on the tariffs.

In such a scenario, welfare functions are determined exactly as before, with the only difference being that governments are uncertain about each other's preferences. Thus, they choose the tariffs and subsidies that maximize expected welfare: in particular, we define the welfare function of home in the *interim* stage (i.e., after observing its own type, but not that of foreign) as

$$W(\tau_x, \tau_y, \tau_x^*, \tau_y^*) = W_x(\tau_x, \tau_x^*) + \frac{1}{N} \sum_{\zeta^* \in \bar{\zeta}} W_y(\tau_y, \tau_y^*(\zeta^*)), \tag{13}$$

while that of foreign takes an analogous form (with the obvious difference that welfare is deterministic in the y market and random in the x market). Note from (13) that welfare on the x market depends only on home's type, since foreign has no private information regarding this good. In the y market, however, foreign's type will affect its tariff and - consequently - the world price of this good. Thus, in choosing its level of subsidy, home maximizes expected welfare in the market for its export good.

It is easy to show that the equilibrium of the asymmetric information case involves the same kind of inefficiency that was previously described. This must indeed be the case, since the introduction of asymmetric information does not eliminate the terms of trade externality and - consequently - governments have an incentive to set inefficiently high (low) import tariffs (export subsidies).

Lemma 1. *The Nash equilibrium of the static game with asymmetric information entails suboptimally high (low) import tariffs (export subsidies).*

Proof. This result stems directly from our previous analysis and the proof is therefore omitted. □

Thus, the properties of the original equilibria are preserved under asymmetric information, entailing suboptimally high tariffs and a consequent loss of efficiency due to the existence of a terms of trade externality. We now analyze a repeated version of the aforementioned game and study its equilibrium payoffs under different scenarios.

3 Repeated Game

Henceforth, we maintain the assumption of two countries, home and foreign, and extend the static model to an infinitely repeated scenario. Each period, both governments receive a private signal ζ (ζ^*) about their political preference, which are independently drawn from a common, uniform distribution with finite support contained in $\bar{\zeta} = \{\zeta_1, \zeta_2, ..., \zeta_N\}$, where $\zeta_1 < \zeta_2 < ... < \zeta_N$. Depending on the scenario considered, each government can set the level of one or more policy instruments.

We analyze this repeated game by using a mechanism design approach (see e.g. Athey et al. [4], Athey and Bagwell [3] and Aoyagi [2]). To illustrate in a simple manner what this means, we will consider a setting in which countries interact repeatedly and communicate with one another. In other words, upon observing their political preferences at each point in time, each government makes an announcement regarding its realization. At each point in time, countries observe each other's announcements regarding their preferences for protection and then set tariffs according to some pre-specified rule. We believe communication between governments before tariff-setting to be a realistic assumption, which in turn allows them to coordinate on the levels at which to set their policy instruments.[7]

Coordination in our repeated game is formally modelled as follows: at the beginning of each period, both governments report their private signals to one another according to a reporting rule

$$\begin{aligned} \hat{\zeta}(\zeta) &: \bar{\zeta} \to \bar{\zeta}, \\ \hat{\zeta}^*(\zeta^*) &: \bar{\zeta} \to \bar{\zeta}. \end{aligned}$$

Once both reports $(\hat{\zeta}, \hat{\zeta}^*)$ have been made, each government must set its tariffs according to some prespecified instruction rule by which they must abide. An instruction rule

$$(i, i^*) : \bar{\zeta}^2 \to R^{2n}$$

is a mapping from announcements to policy instruments, so that R^{2n} represents the policy space for both countries and n denotes the number of instruments available to each government: in our case, these instruments will be alternatively given by import tariffs, export subsidies and transfers of the nummeraire good. The levels of the policy instruments ultimately chosen by any of the governments are publicly observed. Given this communication structure we model the behavior of governments as simply choosing a tariff rule

$$\rho(\rho^*) : \bar{\zeta}^2 \times R^n \to R^n$$

which maps their type, their report and the instruction rule into actual tariffs, subsidies or transfers.

Communication history for a government in period t in the repeated game is the sequence of its reports and instructions in periods $1, 2, ..., t-1$. Private history is the sequence of its private signals ζ in periods $1, 2, ..., t-1$. Finally, public history in period t is a sequence of instruction rules used

[7] Besides allowing for communication, we also require the existence of a randomization device that countries can use to correlate their actions whenever this is necessary. This assumption is standard in the repeated game literature.

at each point in time and the values of the policy instruments actually chosen by both countries in periods $1, 2, ..., t-1$.

Home's (foreign's) strategy σ is a pair of reporting and tariff rules $(\hat{\zeta}, \rho)$ for each period defined as a function of its communication and private histories and of the public history at that time. Define $\hat{\sigma}$ to be the honest and obedient strategy which selects truthful announcements and obedient tariff rules for all histories, i.e., the strategy by which a country always reports its true type and - having done that - sets its tariffs at the levels prescribed by the instruction rule.

Let the coordination scheme C denote the instruction rule that countries agree to follow ex-ante, as a function of communication and public histories. The coordination scheme C is an equilibrium if the pair $\Sigma = (\hat{\sigma}, \hat{\sigma}^*)$ is a perfect public equilibrium (PPE) of the repeated game, i.e., if $\hat{\sigma}$ is optimal against $(\hat{\sigma}^*, C)$ after any public history of the game.

Note that we will characterize equilibrium strategies by using the one-shot deviation property.[8] These deviations, in turn, can be divided into two types which are usually called on- and off-schedule deviations.[9] The latter refer to deviations that are observable, i.e., setting tariffs at a level different from the one indivated by the corresponding instruction rule given public announcements and history: these deviations are always assumed to trigger Nash reversion. On-schedule deviations, on the other hand, are those that arise when countries misrepresent their type: obviously, these deviations are not observable. To control for the latter constraints in the present model we will focus our attention on their local properties, and then prove in each case that they are satisfied globally by the presence of a single-crossing property (SCP).

4 Repeated game with more than one instrument

The present section analyzes the equilibria of the repeated game in the presence of more than one instrument, namely, import tariffs and transfers or import tariffs and export subsidies. In such a setting, the instruction and tariff rules will refer to all of the instruments involved: for example, in the case of import tariffs and transfers, the instruction rule will specify a level for both instruments, and so will the tariff rule used by each country. The question addressed is whether there are efficient equilibria when each country controls more than one instrument.

In the presence of transfers, this question can be answered in a rather straightforward manner. The inefficiency of the model arises precisely because, if countries agree to apply the politically optimal import tariffs associated to their reports, they will both have an incentive to over-represent their type. The reason for this is that they stand to gain by altering the terms of trade in their

[8] The one-shot deviation property is valid in our setup due to the boundedness of per-period payoffs and discounting.
[9] See Athey and Bagwell [3].

favor and against their trading partner, and they do not consider the externality that they generate by doing so. Thus, any coordination scheme that leads countries to internalize this externality will suffice to achieve efficiency.

When transfers are feasible, the simplest such scheme is one by which countries agree ex-ante to pay a transfer equal to the externality they generate while setting their import tariffs at the politically optimal levels associated to their reports. In such a scheme, then, countries have an incentive to report their type truthfully, whereas Nash reversion provides them with the incentives to follow an obedient tariff rule.

The fact that efficiency is attainable in our setting when governments can resort to transfers should not come as a surprise, as it is a common and well-understood result. Thus, we do not prove it here and refer the interested reader to the Appendix. Let $\hat{t}(\hat{\zeta}_t)$ denote the mapping from announcements to transfers that - by internalizing the terms of trade externality - achieves truthtelling and use $\tau^{PO}(\hat{\zeta})$ to denote politically optimal tariffs associated to announcements. We obtain the following result:

Proposition 1. *In the presence of transfers and import tariffs there exists a critical level of the discount factor $\hat{\delta}$, such that for all $\delta \geq \hat{\delta}$, an efficient coordination scheme C characterized by instruction rules $(i_t, i_t^*) = ((\tau_x^{PO}(\hat{\zeta}_t), \hat{t}(\hat{\zeta}_t)), ((\tau_y^{*PO}(\hat{\zeta}_t^*), \hat{t}(\hat{\zeta}_t^*)))$ for all t can be supported as a perfect public equilibrium.*

Note that the possibility of resorting to these two instruments allows countries to achieve efficiency within all periods by transferring welfare between them. In other words, there is no need to resort to the manipulation of future payoffs, because the availability of sufficiently many instruments allows for the achievement of efficiency and incentive compatibility on a period-by-period basis.

However, the use of transfers among countries as direct compensation for tariff increases is something that we seldom observe. There could be a number of reasons behind this lack of transfers, which we do not wish to analyze here: instead, we ask ourselves what would happen in our repeated game if we preclude countries from resorting to transfers.

We consider the effects of such an assumption while allowing countries to resort to export subsidies instead. Note that the preferred level of the latter are not affected by the realization of the own political economy parameter. Thus, the instruction and tariff rules will now refer to the levels of import tariffs and export subsidies. In this case, home's welfare will be given by,

$$W(\sigma, C) = W_x(\zeta, \tau_x(\hat{\zeta}), \tau_x^*(\hat{\zeta})) + \frac{1}{N} \sum_{\zeta^* \in \bar{\zeta}} W_y(\tau_y(\zeta^*), \tau_y^*(\zeta^*)) + v, \tag{14}$$

where τ_x and τ_x^* represent, respectively, home's import tariff and foreign's export subsidy in the market for x. As for foreign's welfare, it can be defined analogously. On-schedule incentive compatibility then requires that

$$W_x(\zeta, \tau_x(\zeta), \tau_x^*(\zeta)) + \frac{1}{N} \sum_{\zeta^* \in \bar{\zeta}} W_y(\tau_y(\zeta^*), \tau_y^*(\zeta^*)) + v \geq$$
$$W_x(\zeta, \tau_x(\hat{\zeta}), \tau_x^*(\hat{\zeta})) + \frac{1}{N} \sum_{\zeta^* \in \bar{\zeta}} W_y(\tau_y(\zeta^*), \tau_y^*(\zeta^*)) + v,$$

for all $\zeta, \hat{\zeta} \in \bar{\zeta}$ and $\hat{\zeta} \neq \zeta$, expression that basically implies

$$W_x(\zeta, \tau_x(\zeta), \tau_x^*(\zeta)) \geq W_x(\zeta, \tau_x(\hat{\zeta}), \tau_x^*(\hat{\zeta})). \tag{15}$$

In order for the previous inequality to be satisfied for any realization of the parameter ζ, it suffices that decreases in export subsidies by the foreign country make the home country internalize the effects of its announcements on the terms of trade. In other words, condition (15) implies that any tariff-subsidy instruction rule satisfying

$$W_x(\zeta, \tau_x(\zeta), \tau_x^*(\zeta)) \geq W_x(\zeta, \tau_x(\hat{\zeta}), \tau_x^*(\hat{\zeta})) \text{ for all } \zeta, \hat{\zeta} \in \bar{\zeta} \text{ and } \hat{\zeta} \neq \zeta, \tag{16}$$
$$\tau_x^{PO}(\zeta) = \tau_x(\zeta) - \tau_x^*(\zeta) \text{ for all } \zeta \in \bar{\zeta}, \tag{17}$$

will support truthtelling and efficient tariffs.[10] Hence, the intuition is esentially the same as it was when countries resorted to transfers: the difference is that, whereas previously countries internalized the externality they generated by attaching a payment to their announcement, here they are led to do so by attaching a decrease in its trading partner's subsudy to their announcement. Because of its similarity with Proposition 1, we do not discuss the formal result here and refer the interested reader to the Appendix.

It suffices to stress here that the presence of export subsidies could in principle help to achieve efficiency on a per-period basis. However, the use of this instrument is currently restricted under the GATT/WTO system.[11] Additionally, note that a coordination scheme like the one described above will repeatedly entail the use of export and/or import subsidies: although in our model countries

[10] The condition for efficiency stems from the fact that - in our setup - world prices ultimately depend on net tariffs. This same feature guarantees that a pair of efficient and IC import tariff and export subsidy always exists.

[11] In this regard, Article 3 of the Agreement on Subsidies and Countervailing Measures explicitly prohibits subsidies which are "contingent, in law or in fact, whether solely or as one of several other conditions, upon export performance."

are not assumed to be liquidity constrained, the latter would seem *a priori* to be a justifiable concern in considering a real-world implementation of the scheme.

Thus, of the two additional instruments that would allow for the implementation of an efficient allocation - transfers and export subsidies - none of them are readily available to countries interacting in the existing trading system. In the next section, we consequently analyze the efficiency of equilibria when import tariffs are the only policy instruments to which countries can resort.

5 Repeated game with one instrument

Once it is assumed that countries can only resort to import tariffs at each point in time, a difficulty arises. Specifically, import tariffs at each point in time must now fulfill a double role: they must achieve efficiency while at the same time providing incentives for truthtelling. The main result of the present section is to argue that in order for efficiency to be attained in such a setting, retaliation is necessary.

5.1 Reciprocal Equilibrium

In the present section, we briefly analyze a scenario in which countries can only resort to their import tariffs, and inquire on the consequences of playing a reciprocal equilibrium. By reciprocal equilibrium we mean an equilibrium that implements a reciprocal tariff withdrawal scheme of the type featured in the GATT escape clause mechanism, in which a country could raise its tariff but this would give its trading partner the simultaneous right to raise its tariff in a reciprocal fashion.

We argue that such an equilibrium must always yield lower welfare than the unique efficient allocation, in which countries set their import tariffs at their politically optimal levels at each point in time. First, note that the efficient allocation can never be an equilibrium in the current setup. The reason is simple. When countries can only resort to their import tariffs, it is efficient for each country's tariff to depend only on the realization of its political economy parameter: however, since the latter is not observed, countries have an incentive to report high types so as to set higher tariffs at equilibrium. If truthtelling is to be induced, then, incentives must somehow be provided and this will come at an efficiency loss.

One possible way of providing incentives for truthtelling is through reciprocal strategies, by which each country's announcement influences the contemporaneous tariffs of its trading partner. To be more precise, consider an equilibrium in which, at each point in time, both countries announce their types and set their tariffs according to some pre-specified instruction rule that relates each tariff to both announcements: in such a way, whenever a county announces that it has a high

preference for protection in its import market on a given period, it increases the expected tariff that its trading partner will set on the other market. As before, observable deviations, in which countries set tariffs different from the ones that had been agreed upon for a given set of announcements, are dealt with through Nash reversion. Let $\tau^r(\hat{\zeta}, \hat{\zeta}^*)$ denote the equilibrium tariff set by home as a function of announcements at the best (symmetric) reciprocal equilibrium, in which governments obtain an expected welfare W^r. That is, out of the set Π of all reciprocal equilibria, τ^r maximizes expected joint welfare.

Is is not hard to argue that any such equilibrium must necessarily be bounded away from efficiency, regardless of countries' discount factors. In fact, any such equilibrium will generate efficiency losses at each point in time. Why? In order for an equilibrium to be efficient, both countries must have incentives to truthfully announce their preferences for protection at each point in time. This can only be true if, in expectation, a higher announcement by any one of the countries increases the tariff set by its trading partner: in particular, the latter increase must be non-negligible, since it must offset the terms of trade gain that a country obtains by claiming to be of a high type. But this, in turn, implies that at each point in time there will be a non-negligible difference between countries' tariffs ex-post and their politically optimal levels. Consequently, such an equilibrium will entail a non-negligible loss of efficiency at each point in time and can therefore not be optimal.

5.2 Role of Retaliation

As opposed to the reciprocal equilibrium that we analyzed above, there are two ways in which retaliation helps enhance efficiency. The first is that, differently from reciprocity, retaliation as we have defined it implies that higher tariffs today by any one country decrease its expected welfare in future periods. By spreading them out across time, then, retaliation may reduce the cost of providing incentives. This point has been emphasized by Riezmann (1991) also in a setting of trade policy with asymmetric information: by applying the results of Green and Porter (1984), Riezmann showed how appropriate trigger strategies could be used to sustain some degree of cooperation. Although useful to enhance cooperation, trade wars in Riezmann's setting cannot sustain the efficient level of cooperation. The reason is that Riezmann focuses on symmetric equilibria in which high tariffs by any one country today increase the likelihood of symmetric trade wars in the future, in which both countries are punished. Restricting the analysis to symmetric equilibria, as we now argue, limits the ability of retaliation to enhance efficiency through a second channel: namely, by providing asymmetric continuation payoffs.

Intuitively, in symmetric equilibria, when the public outcome observed by players is consistent

with deviations, all players need to be punished even if no deviation has actually taken place (as in equilibrium, no deviation occurs). This necessarily generates a loss of efficiency. If we allow for asymmetric equilibria, on the other hand, when the public outcome is consistent with deviation by any one player, this player can be 'punished' while others are 'rewarded'. Hence, incentive compatibility can be achieved without losing (nearly any) overall welfare, but simply redistributing it differently across players.

In technical terms, this idea is expressed by saying that a profile of strategies is enforceable or incentive compatible with respect to hyperplanes. This means that the continuation payoffs that countries expect when playing a particular profile of strategies add up to a constant, so that future welfare can be transferred from one country to the other without affecting total welfare.[12] Note that this property is not satisfied by equilibrium strategies insymmetric equilibria, in which the continuation payoffs of all players need to decrease with some probability in order to achieve incentive compatibility.[13] An asymmetric equilibrium, in contrast, can reduce the efficiency losses needed to induce truthtelling by punishing the deviating country while making the other ones better off, that is, by redistributing total welfare in favor of the latter.

If asymmetric equilibria can outperform symmetric equilibria, how reasonable is it focus on the latter? In our case, we argue, not very reasonable. In games with private information, it is natural to think that players will coordinate their actions on public or observable signals. In general, one could think of environments in which it is not possible to extract the individual actions from the observed public signal. In these cases, symmetric equilibria seem reasonable. In our trade setting, though, the public signal is simply the set of announced preferences for protection by all countries. Hence, the announcements made by different countries are perfectly distinguishable from one anothers, a feature of the environment that seems realistic in the case of trade negotiations. In our case, therefore, it seems less reasonable to focus on symmetric equilibria.

5.2.1 A closed form example of welfare-enhancing retaliation

The present section illustrates in a very simple, closed-form manner the way in which the introduction of retaliation can enhance welfare in a reciprocal equilibrium. In our previous discussion, we explained how in reciprocal equilibria tarffs are never set at their efficient levels.

Suppose instead that countries were to play an equilibrium with retaliation, in which they

[12] In the two country case, saying that the continuation payoffs of the two countries lie on a hyperplane is nothing else than saying that they lie on a straight line with a slope of -1.

[13] The reciprocal equilibria considered previously are an extreme case of symmetric equilibria, in the sense that the continuation payoffs are the same for both countries and that they are equal to the stage game payoff of the reciprocal strategies.

sometimes set their tariffs at their efficient levels and sometimes punish each other. In such an equilibrium, when countries are setting efficient tariffs, higher announcements by any one of them today increases the likelihood that it will be punished tomorrow. Naturally, when a country is punished, it receives a lower payoff than the punishing country. To make our point, though, we will assume that the payoffs of both the punishing and the punished countries will be arbitrarily close to the ones obtained in a reciprocal equilibrium W^r. We now show that the payoffs of such an equilibrium with retaliation, which will be a linear combination of the efficent payoffs and the payoffs from the punishment phases, are higher than in the best reciprocal equilibrium.

To show this result formally in our model, we introduce one modification throughout this section: in order to obtain clear closed-form solutions, we assume a continuum of types.[14] Hence, governments are assumed to draw a political preference parameter from a continuous distribution with support $\bar{\zeta}$ and uniform density g.

Assume that the set of reciprocal equilibria Π is smooth, so that equilibrium tariffs in the best reciprocal equilibrium τ^r can be locally perturbed to introduce asymmetry in payoffs without affecting joint welfare.[15] In such a perturbation, there will be a pair of tariff functions denoted by $\tau^P(\hat{\zeta}, \hat{\zeta}^*)$ and $\tau^R(\hat{\zeta}, \hat{\zeta}^*)$ such that

$$\tau^P(\hat{\zeta}, \hat{\zeta}^*) \leq \tau^r(\hat{\zeta}, \hat{\zeta}^*) \leq \tau^R(\hat{\zeta}, \hat{\zeta}^*) \text{ for all } \hat{\zeta}, \hat{\zeta}^* \in \bar{\zeta}.$$

Hence, in the reciprocal equilibrium that emerges from an asymmetric perturbation like the one above, one country sets tariffs according to $\tau^R(\hat{\zeta}, \hat{\zeta}^*)$ and receives an expected welfare denoted by W^R, whereas the other one sets tariffs according to $\tau^P(\hat{\zeta}, \hat{\zeta}^*)$ and receives an expected welfare denoted by W^P. Keeping this in mind, an asymmetric perturbation $\tau^r(\varepsilon)$ is then defined as the perturbation generating

$$W^R(\tau^r(\varepsilon)) - W^P(\tau^r(\varepsilon)) = \varepsilon.$$

Assume countries adhere ex-ante to the following coordination scheme. First of all, they will cooperate with one another as long as no one deviates in an observable manner. While cooperating, in turn, countries can be either in a punishment phase or in a reward phase: which country starts in which phase is chosen at random before the game starts.

In each period under cooperation, there can be two possible scenarios. With some probability φ, countries find themselves in an efficient scenario in which they announce their preferences and set

[14] By working with a continuum of types, we can invoke differentiability in order to characterize a closed form solution.

[15] This is equivalent to saying that set of expected welfare generated by reciprocal equilibria has a smooth boundary and hence is maximized at τ^* such that $\frac{dW}{d\tau}_{|\tau=\tau^*} = 0$,where $\tau \in \Pi$.

tariffs according to the politically optimal rule. With probability $1-\varphi$, on the other hand, countries find themselves in an asymmetric scenario in which $\tau^r(\varepsilon)$ is used in favor of the country that is in the reward phase. In the former scenario, incentives for truthtelling need to be provided. This will be done by letting announcements induce a probability of switching from the punishment to the reward phase and vice-versa. All things equal, then, by increasing (decreasing) its announcement in the efficient scenario, a country in the reward (punishment) phase increases the probability of switching to the punishment (reward) phase.

Given the announcement, the probability that a country in the reward state switches to the punishment state is denoted by $\pi(\hat{\zeta}, \hat{\zeta}^*)$. Clearly the probability is symmetric for the country in the punishment state and denotes the likelihood of moving to the reward state.

In order to establish the existence of an equilibrium and to analyze its welfare properties, we formulate governments' decision problems in a recursive fashion and solve for incentive compatibility. Let v^R and v^P denote, respectively, the average payoffs that a government obtains from the coordination scheme in the reward and the punishment states. Given the transition probability function π, v^R and v^P must satisfy[16]

$$v^R = (1-\delta)\left[\varphi W^{PO} + (1-\varphi)W^R\right] + \delta[\varphi(\pi v^P + (1-\pi)v^R) + (1-\varphi)v^R], \tag{18}$$

$$v^P = (1-\delta)\left[\varphi W^{PO} + (1-\varphi)W^P\right] + \delta[\varphi(\pi v^R + (1-\pi)v^P) + (1-\varphi)v^P]. \tag{19}$$

Additionally, π must satisfy on-schedule IC constraints, since it must induce truthtelling during the phase in which the political optimal rule is to be used. In that case we have, for the country in the reward state:

$$\left.\frac{\partial[\int_{\zeta_L}^{\zeta_H} \pi(\hat{\zeta}, \zeta^*)g(\zeta^*)d\zeta^*]}{\partial\hat{\zeta}}\right|_{\hat{\zeta}=\zeta} = \frac{(1-\delta)\left.\frac{\partial W^{PO}(\zeta,\hat{\zeta})}{\partial\hat{\zeta}}\right|_{\hat{\zeta}=\zeta}}{\delta(v^P - v^R)}, \tag{20}$$

expression that we can integrate to obtain

$$\pi(\hat{\zeta}, \hat{\zeta}^*) = \frac{1}{2} + \frac{(1-\delta)}{\delta(v^P - v^R)}\left[W^{PO}(\hat{\zeta}) - W^{PO}(\hat{\zeta}^*)\right]. \tag{21}$$

Rewriting $v^R - v^P$ from (19) and (18) and replacing in (21):

$$\pi(\hat{\zeta}, \hat{\zeta}^*) = \frac{1}{2} + \frac{1-\delta(1-\varphi)}{\delta(1-\varphi)(W^R - W^P)}\left[W^{PO}(\hat{\zeta}) - W^{PO}(\hat{\zeta}^*)\right]$$

[16] Note that, formally speaking, W^{PO} includes expected welfare in both the import and export markets and thus depends through the latter on foreign's announcement. However, since we focus here on the effect of own announcements on the import market, we treat this current payoff as depending only on such announcements.

Finally, it needs to be verified that our coordination scheme has an equilibrium or, in other words, that $\pi(\hat{\zeta}, \hat{\zeta}^*)$ as defined above is in fact a probability. Normalize $\pi(\zeta_H, \zeta_L) = 1$ and let Δ denote the difference $W^{PO}(\zeta_H) - W^{PO}(\zeta_L)$. Then, the coordination scheme has an equilibrium if and only if the probability of the symmetric scenario arising φ is given by

$$\frac{\delta\varepsilon - (1-\delta)2\Delta}{\delta(\varepsilon + 2\Delta)},$$

which is strictly increasing in payoff asymmetry ε. Note that, for any level of asymmetry $\varepsilon > 0$, there exists a critical level of patience denoted by δ_ε such that, for all $\delta > \delta_\varepsilon$

$$\varphi(\delta, \varepsilon) > 0.$$

We are now ready to show that our coordination scheme can deliver a payoff strictly greater than that of the best reciprocal equilibrium W^r. It is worthwhile to remember that, by definition of $\tau^r(\varepsilon)$, $W^P + W^R \approx 2W^r$ since minor asymmetric perturbations of the best reciprocal tariff will not have first-order effects on joint expected welfare.

Total expected welfare from the coordination scheme given an ε level of asymmetry and assuming $\delta > \delta_\varepsilon$ is therefore given by:[17]

$$v(\varepsilon) = \frac{v^R + v^P}{2} = \varphi(\delta, \varepsilon) \cdot W^{PO} + (1 - \varphi(\delta, \varepsilon)) \cdot \left(\frac{W^R + W^P}{2} \right). \tag{22}$$

Since we want to compare this scheme with the reciprocal equilibrium ($\varepsilon = 0$), we evaluate the expected payoffs of the coordination scheme at the limit $\varepsilon \to 0$, $\delta \to 1$ and analyze the effects of introducing asymmetry. Formally

$$\frac{dv}{d\varepsilon}_{|\varepsilon=0} = \frac{\partial\varphi(1,0)}{\partial\varepsilon} \left[W^{PO} - \left(\frac{W^R + W^P}{2} \right) \right] + \frac{\partial \left(\frac{W^R + W^P}{2} \right)}{\partial\varepsilon}_{|\varepsilon=0} (1 - \varphi(1,0)) > 0. \tag{23}$$

As can be seen from Equation (23), then, the introduction of asymmetry in the best reciprocal equilibrium is welfare enhancing. Inequality (23) is important in the sense of showing that the result is not a local improvement around $\varepsilon = 0$. In fact, it implies that there must be some strictly positive level of asymmetry $\varepsilon^{OPT} = W^R - W^P > 0$ that maximizes the cooperation between the governments generated by such a coordination scheme.

To summarize, our argument is as follows. Suppose that we start with the best reciprocal equilibrium that generates expected welfare W^r. Then, there is an equilibrium that involves some

[17] Note that $\delta_\varepsilon \to 1$ as $\varepsilon \to 0$. This is natural since, given arbitrarily small levels of asymmetry, arbitrarily high degrees of patience are required for incentive compatibility.

degree of retaliation and that does strictly better. In such an equilibrium, governments at each point in time either set their tariffs the politically optimal level - in line with their announcements - or they play an asymmetric perturbation of the best reciprocal equilibrium. When the politically optimal rule is used, incentive compatibility is obtained by letting announcements determine the probability of being punished next period. We have thus shown that the introduction of asymmetry makes it possible for governments to enhance their cooperation, so that retaliation is welfare enhancing.[18]

5.2.2 General argument on retaliation and efficiency

The previous example has sought to show in an intuitive, closed-form manner, the way in which retaliation can be useful to enhance welfare beyond what reciprocity can yield. In the example, though, the equilibrium payoffs are still bounded away from efficiency. We now argue that, not only can the introduction of some retaliation be welfare enhancing but it is also necessary to achieve efficiency in our model.

Our argument relies on the theoretical result obtained by Fudenberg et al. (1994, henceforth FLM), who prove a folk theorem for repeated games with private information. Their result translated to our model is that, in this class of games, all payoffs higher than those of autarky can be sustained as a perfect public equilibrium when governments become infinitely patient: in particular, this implies that efficient cooperation can be attained in equilibrium.[19]

As our previous discussion suggests, asymmetric equilibria play a very important role in the possibility of achieving efficient cooperation. Technichally, the latter is possible in games in which players are privately informed about their types insofar as the game has a product structure. What this means is that the public outcome of a game - that is observed by all players - has the same number of components as players there are, and each of these components is independent from the others and only affected by the actions of one of the players.

This result translates very clearly to games of communication like the trade setting of the current paper. In our setting, governments announce to each other their preference for protection at each point in time: the public outcome, hence, that is observed by all, is the profile of announcements made by both governments. Since announcements made by different countries are clearly distinguishable from one another, the environment clearly has a product structure. In such a scenario, efficiency is possible and requires asymmetric continuation payoffs; asymmetric retaliation, then, is

[18] It is worthwile to note that exactly the same result would be obtained if we would slightly perturb symmetric "trade war" equilibria studied in Riezmann (1991). That is, introducing retaliation of top of the trade wars can enhance cooperation compared to symmetric trade war equilibria).

[19] The results actually says that asymptotic efficiency can be reached. The more patient governments are, payoffs can be sustained that are closer to efficient cooperation. In the limit ($\delta \to 1$) efficient cooperation is obtained.

necessary for efficiency.[20] Since potential deviations by any one country are clearly distinguishable from those of others, it makes sense that efficiency is possible insofar as higher announcements today imply lower payoffs tomorrow.[21]

To make the argument formally, we now invoke the folk theorem for repeated games of private information, which applies exactly to our game as formally described in Section 3. It is worthwhile to remember that we define a coordination scheme C as the set of instruction rules that countries agree to follow ex-ante, as a function of communication and public histories. The coordination scheme C is an equilibrium if the pair $\Sigma = (\sigma_C, \sigma_C^*)$ is a perfect public equilibrium (PPE) of the repeated game, i.e., if the truthful and obedient announcement and tariff rule σ_C is optimal against (σ_C^*, C) after any public history of the game.

Let $W(i)$ be the per-period payoffs when players are truthful and obediently follow instruction rule i. It is said that the coordination scheme C implements an instruction rule i if it is an equilibrium and yields expected average discounted payoffs $W(i)$. The following theorem holds (FLM):

Theorem 1. *Fix an instruction rule i and a Nash Equilibrium σ^N of the corresponding one-shot tariff game, and suppose that the distribution of types is independent across countries. Let V^0 be the set formed by the convex hull of $W(\sigma^N)$ and the feasible points that pareto dominate it. If V^0 has a non-empty interior, then all payoff vectors in V^0 can be approximated by equilibrium coordination schemes for discount factors close enough to 1. In particular, if $i^{PO} = \zeta^2 \rightarrow (\tau^{PO}(\zeta, \zeta^*), \tau^{*PO}(\zeta, \zeta^*))$, then there exists an equilibrium coordination scheme C that (approximately) implements i^{PO} for all δ sufficiently close to* 1.

Proof see FLM (1994), p. 1030

In particular, the coordination scheme C^r corresponding to the best reciprocal equilibrium τ^r, as well as the coordination scheme C^{PO} corresponding to the political optimal tariff rule τ^{PO}, can be (approximately) supported as equilibria. We wish to stress again that this result is based on the fact that the structure of the tariff game is such that governments can distinguish each others' actions. This feature is what ultimately allows them to redistribute future welfare according to

[20] It is important to stress that this folk theorem in the case of private information does not tell us how strategies need be constructed in order to sustain the most efficient cooperation. In other words, the exact structure of the asymmetric strategies that induce efficiency is not specified and that is why we provided the closed form example of the previous subsection.

[21] In other words, the possibility of redistributing future welfare between governments can only be of help if they can be held responsible individually (in a statistical manner) for their actions. When, after observing some public outcome, it cannot be established statistically whether one government or another is most likely to have deviated, asymmetric continuation payoffs cannot be used in order to induce truthtelling. This is the case since it will not be possible to determine who should receive a lower or a higher continuation payoff.

present actions, and to do so with a minimal loss of joint welfare as they become very patient.

6 Application to antidumping

So far we have shown that, for our current trade environment in the presence of private information, retaliation is a necessary feature of any equilibrium that attains (asymptotic) efficiency. We now ask ourselves whether retaliation is actually being observed in reality, and argue that there is at least one instance in which it apparently is: the use of antidumping measures.

6.1 Evidence regarding antidumping measures

Over the last two decades, the use of antidumping (henceforth, AD) has increased significantly. According to Prusa [26], there were 69 AD complaints filed or reported to GATT in 1980: by 1998, this figure had increased to 246. Not only did the use of AD intensify among "traditional" users during this period, but it was also adopted by countries who had not used it before, tripling the total number of nations using it by 1998.

Along with this increase in the use of AD, there has been a shift in the perception of the incentives that underlie its use. The traditional explanation was based on the existence of dumped imports, goods sold either at a price below the one in the exporter's domestic market or at a price below his costs of production. The use of AD duties under such circumstances is allowed by the GATT/WTO code whenever the dumped imports are proven to have caused material injury to domestic firms.

More recently, however, various authors have suggested that the underlying reasons for AD could be "strategic" in nature. In particular, there seems to be ample evidence that a significant motive behind AD filings lies in its retaliatory use by the involved parties. In this sense, Finger [15] has argued that countries that use AD tend to apply it against each other, and not against countries that do not use this instrument to begin with. To back this claim, he notes that during the 1980's approximately two thirds of AD cases were filed against countries who also used this type of duties. Along the same lines, Prusa [26] has argued that many countries appear to file for AD duties against countries who have done the same to them in the past.

In an extensive empirical study, Prusa and Skeath [27] have analyzed the trends in worldwide AD filing during the past two decades, trying to explain the motives underlying the use of this measure. To do so, they use data on all AD cases filed or reported to the GATT/WTO between 1980 and 1998 to test for evidence of economic and strategic motives. In terms of the former, they look for evidence of AD cases being filed against large suppliers or suppliers who have large

percentage surge in imports. In terms of strategic motives, they look for indications of "club" or retaliatory filings of AD cases. "Club" filings refer to the use of AD against countries that have previously used this instrument themselves, regardless of whom they have used it against. Retaliatory filings, on the other hand, are those carried out by a country against trading partners that have in turn used AD against it in the past.

Their results seem to provide strong support for the strategic view of antidumping. In particular, they find that of all AD cases filed between 1980 and 1998, three-quarters of them are consistent with the club effect and one half are consistent with retaliation incentives. Additionally, their statistical tests on annual filings at the country level suggest that about 50% of the observations provide statistically significant support for the strategic hypothesis. These results, by which the observed use of AD seems to be consistent with strategic motives, were confirmed by the authors in a subsequent study.[22]

Adopting a different line of research that focuses on industry filing decisions in the United States, Blonigen and Bown [11] have recently found evidence suggesting that the use of AD is affected by the threat of retaliation through the same channel. In particular, they find that industries seem less likely to initiate petitions against firms from countries which have active AD provisions and are at the same time an important destination for their exports. Additional empirical work that looks for evidence of retaliatory behavior in the use of AD includes the paper by Feinberg and Olson [14], who look at WTO data on AD-filings and conclude that a substantial proportion of them are in line with retaliatory motives.

6.2 Interpretation of retaliatory AD

As we mentioned in the introduction, this increasing evidence regarding the strategic or retaliatory use of antidumping has led many to argue in favor of eliminating this policy tool altogether. In light of the results of the present paper, though, the retaliatory use of AD might actually be welfare enhancing in a world of restricted trade instruments.

The repeated model of Section 5 can be loosely applied to the case of AD measures. First of all, note that - if interpreted in an extreme way - the aforementioned evidence seems to indicate that there is no such thing as *antidumping* measures, only premiums added to tariffs for strategic reasons.[23] Moreover, the use of AD seems to be significantly influenced by political lobbying,

[22] See Prusa and Skeath (2004).

[23] Of course, some of the use of AD does in fact respond to the existence of dumped imports: in any case, the latter can be explained through the traditional economic reasoning, and our model deals only with the strategic use of this instrument.interpret tariffs as AD duties.

at least in the United States.[24] Hence, our model, in which countries adjust their tariffs in a discretionary manner according to political preferences does not seem ill-suited to think about AD measures.

If it is assumed that baseline tariffs are relatively stable, and AD is used as a way to accommodate them to shifting political preferences, then a theory of retaliatory AD is essentially a theory of retaliatory tariffs. This is exactly the approach we adopt in the Appendix, where we show that - in a world of rigid baseline tariffs and changing political preferences - some degree of retaliation is welfare enhancing. Some clarification is required.

In the first place, the fact that it is efficient for tariffs to change in light of changing political preferences does not seem very controversial: the problem is, what is to keep governments from abusing such an instrument in order to influence terms of trade in their favor? We have tried to answer this question previously in the paper by analyzing different scenarios: in particular, we have shown that an adequate system of transfers or export subsidies will prevent governments from misreporting their preferences, thus achieving efficiency on a per-period basis. The use of transfers, however, is rarely observed in the world, whereas the use of subsidies is restricted both by WTO/GATT and - potentially - by liquidity constraints.

Once we remove these policy instruments, then, we are left only with import tariffs. We have shown that, in such a scenario, it is conceptually necessary to entertain some retaliation in order to achieve efficiency. In our particular application to AD, we show in a very simple manner that some degree of retaliation is welfare enhancing with respect to a static rule regulating the use of this instrument. Governments accommodate their tariffs to shifting political preferences, but high reports by any one of them today - and, therefore, higher tariffs today - will generate higher expected tariffs on behalf of their trading partner tomorrow. Thus, it is retaliation and the threat of retaliation what achieves incentive compatibility in our model.[25]

Of course, our application is admittedly simplistic in treating AD simply as tariffs which may be freely adjusted by governments. This simplification, though, does not seem substantially restrictive if - as the critics of AD claim - this instrument is to a large degree being used in an arbitrary fashion that bears little relation to the objectives for which it was created. In this sense, it is important to highlight the extent to which the debate over AD has spread when compared to other policy instruments, such as safeguards: one of the reasons which might account for the difference in the treatment dispensed to these apparently similar instruments seems to be precisely that the way in

[24] See Hansen (1990), Moore (1992) and Hansen and Prusa (1997) for evidence regarding the importance of political considerations in the use of AD by the United States. Francois and Niels (2004) provide evidence for the case of Mexico.

[25] In the Appendix, we have chosen to convey the point in the way which seems the most straightforward for the purposes of this paper.

which the latter is designed discourages governments from using it arbitrarily. In fact, not only is the standard for establishing injury stricter under a safeguard action than under AD regulations[26], but - for the period to which the cited empirical studies refer - the use of safeguards has also entailed compensation for the damaged party.[27]

In spite of these simplifications, however, we feel that this application illustrates clearly the conceptual idea we have tried to convey while being consistent with the evidence regarding the use of AD: namely, than in a world of restricted instruments, the strategic or retaliatory use of the remaining ones may be the most efficient way to deal with hidden information. In Tinbergen's terms, it could be said that the instruments available to countries should be analyzed jointly and in relation to the objectives which are to be attained. We believe that this should be kept in mind when designing rules for international cooperation since, in restricting the use of some of the instruments usually available to governments, these rules might trigger the use of other instruments in new and unforeseen ways.

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[26] In particular, the domestic industry must demonstrate the presence or threat of *serious* injury.

[27] Although this has changed with the advent of the WTO, the existence of compensation is still central to the application of safeguards. As the WTO states in its description of this measure,

"When a country restricts imports in order to safeguard its domestic producers, in principle it must give something in return. The agreement says the exporting country (or exporting countries) can seek compensation through consultations. If no agreement is reached the exporting country can retaliate by taking equivalent action for instance, it can raise tariffs on exports from the country that is enforcing the safeguard measure. In some circumstances, the exporting country has to wait for three years after the safeguard measure was introduced before it can retaliate in this way..."

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7 Appendix

7.1 Repeated model with transfers and tariffs

In the presence of transfers and tariffs, the welfare of home would be defined as

$$W(\sigma, C) = W_x(\tau_x^{PO}(\hat{\zeta}), \zeta) + t(\hat{\zeta}) + \frac{1}{N}\sum_{\zeta^* \in \bar{\zeta}} W_y(\tau_y^{*PO}(\zeta^*)) + v, \tag{24}$$

where we assume the use of an obedient tariff rule and $\tau_x^{PO}(\hat{\zeta})$ denotes the politically optimal tariff, $t(\hat{\zeta})$ denotes the transfer implied by the coordination scheme and v represents the continuation payoff.

Local on-schedule incentive compatibility then requires that

$$W_x(\tau_x^{PO}(\zeta),\zeta)+t(\zeta)\geq W_x(\tau_x^{PO}(\hat{\zeta}),\zeta)+t(\hat{\zeta}),$$

for all $\zeta,\hat{\zeta}\in\bar{\zeta}$ and $\hat{\zeta}>\zeta$ which, in terms of (24), implies

$$t(\hat{\zeta})-t(\zeta)\geq W_x(\tau_x^{PO}(\hat{\zeta}),\zeta)-W_x(\tau_x^{PO}(\zeta),\zeta). \tag{25}$$

Obviously, then, any instruction rule that calls for the use of politically optimal tariffs and a transfer function satisfying,

$$\begin{aligned} t(\zeta_1) &= 0 \\ t(\zeta_{i+1})-t(\zeta_i) &= W_x(\tau_x^{PO}(\zeta_{i+1}),\zeta_i)-W_x(\tau_x^{PO}(\zeta_i),\zeta_i) \text{ for } i=1,2,...,N, \end{aligned} \tag{26}$$

will be enough to achieve efficiency while satisfying on-schedule incentive compatibility constraints (henceforth, we denote a transfer function satisfying (26) as $\hat{t}$). In the first place, such an instruction rule will make it optimal for importing countries to truthfully reveal their type, for the simple reason that the incentive to over-represent disappears through the transfer.[28] Additionally, efficiency is guaranteed by the fact that the instruction rule entails the use of politically optimal tariffs for all reports: since the latter will be truthful, import tariffs will consequently be set at their efficient levels.

The last issue we need to address is whether the off-schedule incentive compatibility constraints are satisfied. In other words, will both countries use efficient tariff rules? Since, as we said before, observable deviations trigger Nash-reversion, this will be the case if countries are sufficiently patient. This proves our proposition.

7.2 Repeated model with tariffs and subsidies

The idea behind conditions (16) and (17) in the main body of the paper is as follows: suppose that countries agree ex-ante on some arbitrary value for world prices (say, without loss of generality, the

[28] Global incentive compatibility is given by the fact that our model satisfies the SCP, since the marginal welfare of an increase in the domestic price of the import good increases with ζ.

world price that would result from applying the politically optimal import tariffs when the realized ζ is equal to its expected value). Condition (16) basically says that world prices will always remain at that level, since import tariffs and export subsidies will respond to the announcement in such a way as to keep it invariant. Thus, tariffs and subsidies will always lie on the same iso-world price locus regardless of announcements. However, the exact point on the locus on which they lie will depend on the announcement, since efficiency requires that (17) be satisfied at all points in time. Therefore, (16) and (17) jointly state that tariffs and subsidies in each market should be set at the intersection of some pre-specified iso-world price locus and the efficiency locus corresponding to the announcement.

If we denote tariffs and subsidies satisfying (16) and (17) by $\hat{\tau}_x(\hat{\zeta})$ and $\hat{\tau}_x^*(\hat{\zeta})$, a rule instructing the importing and exporting countries to set their tariffs and subsidies at such levels would clearly satisfy both efficiency and incentive compatibility for the importing country.[29] Global incentive compatibility, on the other hand, stems once again from the fact that the marginal welfare of an increase in the domestic price of the import good is increasing in ζ.

These conditions are very intuitive: the desire to overclaim one's type arises from the potential benefit of favorably affecting the terms of trade. However, if the coordination scheme is such that the exporting country's subsidy decreases so as to eliminate the terms of trade effect associated to each report, there is no incentive to lie about one's type. This, in turn, can always be done in our setting since there is no private information regarding the export sector. Efficiency comes from the observation that, in the present model, all that matters for total welfare is the difference between import tariffs and export subsidies: as long as this difference is equal to the politically optimal import tariff, total welfare is maximized.[30]

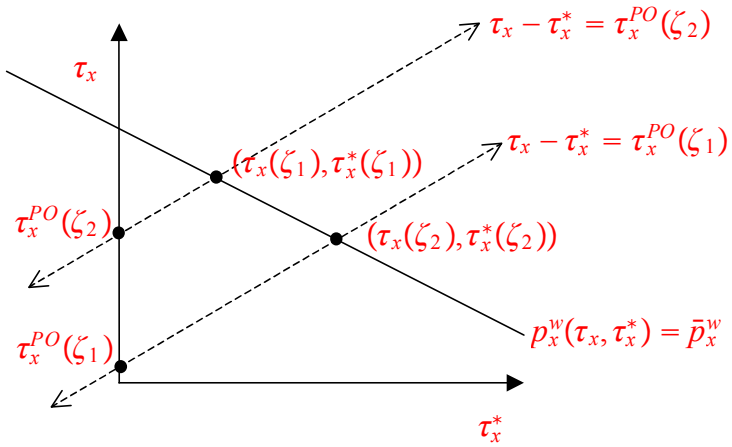
The following figure illustrates the discussion. Suppose the world price is set at a pre-specified level which we denote $\bar{p}_x^w$: the iso-world price locus in the graph shows all the combinations of import tariffs and export subsidies that deliver this price in equilibrium. Now, for two values of the political economy parameter in the importing country, ζ_1 and ζ_2 where $\zeta_2 > \zeta_1$, the upward sloping loci represent the efficiency frontiers, i.e., combinations of tariffs and subsidies that maximize joint welfare.[31] All the mechanism does is to instruct, for each announcement made by the importing country, the tariff-subsidy pair that lies on the intersection of the iso-world price line

[29] Note that efficiency rests on the assumption of private information only in the import side of the market. Thus, tariffs and subsidies need only be adjusted in response to the importing country's announcement in order to achieve efficiency.

[30] This can be seen from the fact that, when we add governments' welfare in any one market, the joint welfare depends only on; a) the difference between the import tariff and the export subsidy, and b) local prices. The latter, in turn, depend only on the former (see Section 2.1).

[31] Obviously, they yield the same joint welfare as the pair $(\tau_x^{PO}(\zeta), 0)$.

and the corresponding efficiency locus: in this way, world prices are kept constant, eliminating the terms-of-trade externality while achieving efficiency.



Efficient Coordination Scheme with Tariffs and Subsidies

Finally, since such a mechanism maximizes joint expected welfare, world prices in both markets can always be chosen so as to avoid off-schedule deviations in the presence of Nash-reversion if countries are sufficiently patient. The following proposition summarizes the previous discussion.

Proposition 2. *In the presence of export subsidies and import tariffs there exists a critical level of the discount factor $\hat{\delta}$, such that for all $\delta \geq \hat{\delta}$, an efficient coordination scheme C characterized by instruction rules $(i_t, i_t^*) = ((\hat{\tau}_x(\hat{\zeta}_t), \hat{\tau}_y(\hat{\zeta}_t^*)), ((\hat{\tau}_x^*(\zeta_t^*), \hat{\tau}_y^*(\hat{\zeta}_t^*)))$ for all t can be supported as a perfect public equilibrium.*