Threats and Promises in Tariff Settings*

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Abstract

The paper analyzes tariff-settings by two large countries, in an alternating move, infinitely repeated game. We find that there exist multiple Markov perfect equilibria in which countries gradually lower their individual tariff rates. Each country has an incentive to lower its tariff rate since it is to be reciprocated by the other country. However, countries will not eliminate their tariffs completely in any Markov perfect

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equilibrium except in the limit case where they do not discount the future.

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1 Introduction

Why do some countries sometimes liberalize trade unilaterally? Trade theory tells us that trade liberalization benefits the country as long as the country is small. But why even large countries sometimes liberalize trade unilaterally? A notable example is Britain’s unilateral trade liberalization in 1840s, including the repeal of the Corn Laws in 1846 (Conybeare, 2002). Did Britain act unilaterally because it believed that unilateral trade liberalization itself should benefit Britain? Or did Britain hope that other countries follow suit? Bhagwati (2002) argues that the latter idea occurred to British Prime Minister Sir Robert Peel who showed leadership in abolishing the Corn Laws. Indeed, most European countries liberalize trade after 1840’s, following the continual free trade movement by Britain (Bairoch 1989, Kindleberger, 1975). History has witnessed what Bhagwati (2002) calls “sequential reciprocity.”

Why can a country expect other countries to reciprocate its trade liberalization? Krishna and Mitra (1999) show that unilateral trade liberalization induces reciprocal tariff reduction through endogenous lobby formation in the foreign country’s export good industry. Coates and Ludema (2001) also show that unilateral trade liberalization helps the foreign country to ratify a trade agreement by reducing lobbying activities in the foreign import-competing sectors that are against the trade agreement. There is no doubt that lobbying activities play important roles in countries’ selection of trade policies. It is not difficult to believe that unilateral trade liberalization changes the environment for lobbies, and thereby induces the lobbies to act for foreign countries’ trade liberalization in some occasions.

In this paper, however, we provide a simpler explanation as to why countries liberalize trade unilaterally: Countries liberalize trade unilaterally since they believe (correctly) that it is to be reciprocated. By lowering the tariff rate, a country creates a position to threaten to raise trade barriers unless other countries do not reciprocate. Tariff reduction means at the same time carrying out an implicit promise to reciprocate other countries’ trade liberaliza-
tion. The meaning of tariff reduction is twofold: threats and promises. Due to this property, a unilateral tariff reduction induces the sequential, multilateral, trade liberalization.

The idea that the threat of sanction induces players’ cooperation is not new. In the framework of repeated tariff setting, Dixit (1987) appeals to a trigger strategy to show that countries can sustain liberalized trade with low tariffs. Although his theory successfully explains how cooperation in tariff settings can be sustained, automatic retaliation that follows immediately after a deviation is not very realistic as we seldom observe punitive retaliatory actions. Indeed, it is reasonable for countries to refrain from punishing a deviant as punishment is costly not only to the deviants but often to themselves. However, in simultaneous move, infinitely repeated, tariff setting games, countries will not fail to punish a deviants since a deviation automatically alters the phase to the punishment phase in which they would incur a higher cost if they fail to punish the deviant.1

In this paper, we model two countries’ tariff settings as an alternating move, infinitely repeated game. In an alternating move game, the country that has suffered from a deviation can prevent entering the punishment phase by simply ignoring the deviation. Thus, we can meaningfully investigate the incentive for countries to punish deviants. Moreover, we can capture the realistic information structure that when countries choose their trade policies they can observe other countries’ concurrent trade policies. Maskin and Tirole (1988) suggest another rationale for alternating move games that they are effectively the same as games with endogenous timing of players’ moves, which suits the analysis of countries’ tariff settings. In this framework, we derive Markov perfect equilibria in which each country’s tariff setting only depends on the other country’s current tariff rate. We investigate whether or not countries achieve tariff cooperation in this minimally history dependent environment.

1In Nash reversion trigger strategy, for example, a deviation induces all countries including a deviant to select their individual Nash equilibrium tariffs from the next period onward. Selecting a tariff rate other than the Nash equilibrium tariff is costly and will not end the punishment phase, so every country will select its Nash tariff once a country deviates in the initial cooperation phase.
Even though each country’s tariff setting depends only on the other country’s current tariff, there are Markov perfect equilibria in which countries gradually cut their individual tariffs. In such an equilibrium, a country unilaterally lowers its tariff rate, since it is to be reciprocated by the other country in the next period. Except in the limit case where countries do not discount the future, however, even Pareto efficient Markov perfect equilibria will not induce countries to completely eliminate their tariffs. The costs of unilateral tariff reduction arise immediately, whereas the benefit from the induced tariff reduction by the other country emerges in the next period. Therefore, as long as countries discount the future, they lack incentive to lower their individual tariffs all the way down to zero.

Eaton and Engers (1992) analyze a related problem in an alternating move game. In their model, the sender may impose a sanction, which is costly to both sender and target, to urge the target to comply. Whereas in our model, two players are symmetric in that both play roles of sender and target. Moreover, the one-shot game of our model has a structure of the prisoner’s dilemma so that sanctions are costly only to the punished player.

Johnson (1953-54) investigates the interaction of optimal tariff settings between two large countries. In his model, countries alternately select their individual tariffs that are myopically best response to the tariff that the other country has selected in the last stage. The tariff profile either converges to the one-shot Nash equilibrium or to a tariff cycle around the Nash equilibrium. Our result contrasts with Johnson’s in that in our Markov perfect equilibrium the tariff rates converge to a tariff profile in which each country’s tariff rate is smaller than its Nash equilibrium tariff rate. In our model, countries take into consideration the response of the other country when they select their individual tariff rates. That is why each country has incentive to select a tariff that is smaller than its myopically best response to the other country’s current tariff.

To our knowledge, this paper of ours is the first work since Johnson’s (1953-54) that investigates the interaction of tariff settings between two large countries in an alternating
move game even though the framework fits better to the reality than the commonly used simultaneous move games.

2 The Model

We consider an alternating move, tariff setting game between two large countries, 1 and 2. Each country consumes three goods: Country 1’s export good, Country 2’s export good, and a numeraire good. Consumers’ preferences are represented by quasi-linear utility functions that are additively separable for the three goods and are linear with respect to the numeraire good. Thus, we can proceed with the partial equilibrium analysis for the two non-numeraire goods. Social welfare of each country is represented by the total surplus derived from the markets of the non-numeraire goods, which in turn can be measured by gains from trade (the sum of import surplus and export surplus) since the total surplus is the sum of the predetermined total surplus in autarkic equilibrium and gains from trade. Country i’s import demand is a decreasing, continuous function of price such that it takes the value zero at Country i’s autarkic equilibrium price, whereas its export supply is an increasing, continuous function of price for its export good.

Each country imposes a tariff only on the non-numeraire good that the country imports. Let \( \tau_i \in \mathbb{R}_+ \), for \( i = 1, 2 \), denote Country i’s specific tariff rate, and let \( m_i(\tau_i) \) and \( x_i(\tau_j) \), where \( j \neq i \), denote Country i’s import surplus (inclusive of tariff revenues) and export surplus, respectively.\(^2\) Each country’s import surplus, which is the area below the import demand curve and above the world price level, is a continuous function of its own tariff rate. The function \( m_i \) is increasing where \( \tau_i \) is small and decreasing where \( \tau_i \) is large reflecting the optimal tariff theory. We assume for simplicity that \( m_i \) has a single peak at \( \tau_i^N > 0 \). On the other hand, each country’s export surplus, which is the area below the world price level and above the export supply curve, is a decreasing continuous function of the other country’s

\(^2\)Qualitatively the same results obtain even if we allow \( \tau_i \) to take negative values, i.e., import subsidies.
tariff rate.

Let \( \bar{\tau}_i \) denote the critical tariff rate at which Country \( i \)'s import ceases. Since Country \( i \)'s import demand function and Country \( j \)'s export supply function take the value zero at these countries’ respective autarkic equilibrium prices for the good, \( \bar{\tau}_i \) equals the difference between these prices. Thus, \( m_i \) is increasing on \([0, \tau_i^N)\) such that \( m_i(0) > 0 \), decreasing on \((\tau_i^N, \bar{\tau}_i)\), and equal to zero on \([\bar{\tau}_i, \infty)\). On the other hand, \( x_j \) is decreasing on \([0, \bar{\tau}_i)\) with \( x_j(\tau_i) = 0 \) for \( \tau_i \geq \bar{\tau}_i \). Now, Country \( i \)'s one-shot payoff is written as

\[
u_i(\tau_i, \tau_j) = m_i(\tau_i) + x_i(\tau_j). \tag{1}
\]

Since a tariff on Country \( i \)'s imports creates market distortions, \( m_i(\tau_i) + x_j(\tau_i) \) is maximized at \( \tau_i = 0 \). This implies that free trade \((\tau_1, \tau_2) = (0, 0)\) is Pareto efficient, i.e., the contract curve passes through the origin of the tariff space.

Let \( T_1 = \{1, 3, 5, \cdots\} \) and \( T_2 = \{2, 4, 6, \cdots\} \) denote the sets of periods in which Country 1 and Country 2 select their individual tariff, respectively. We derive Markov perfect equilibria of the game in which each country’s strategy is to select its tariff rate according to a function of the other country’s current tariff rate. In period \( t \in T_1 \), Country \( i \) selects its tariff rate \( \tau_{i,t} \) for a given \( \tau_{j,t} \), the state variable in period \( t \in T_i \). Since Country \( i \) will not have an option to change its tariff rate in period \( t + 1 \), we have that \( \tau_{i,t} = \tau_{i,t+1} \) for \( t \in T_i \). Let \( \mathcal{F}_i \) be the set of all functions from \( \mathbb{R}_+ \) to \( \mathbb{R}_+ \) and let \( f_i \in \mathcal{F}_i \) denote the pure-strategy Markov perfect equilibrium (MPE) strategy for Country \( i \). Also let \( \delta_i \) denote Country \( i \)'s discount factor. Then, for a given \( \tau_{2,1} \) and Country \( j \)'s MPE strategy \( f_j \), the sequence of tariffs that is generated by \( f_i \) solves the following maximization problem:

\[
\max_{(\tau_{i,t}) \in \mathcal{T}_i} \sum_{t=1}^{\infty} \delta_i^{t-1} [m_i(\tau_{i,t}) + x_i(\tau_{j,t})] \tag{2}
\]

s.t.
\[
\tau_{i,t+1} = \tau_{i,t} \quad \text{for } t \in T_i,
\]
\[
\tau_{j,t+1} = \tau_{j,t} = f_j(\tau_{i,t}) \quad \text{for } t \in T_j,
\]
\[
\tau_{2,1} \text{ given}
\]
3 Multiple Markov Perfect Equilibria

In this section, we derive Markov perfect equilibria of the tariff setting game and examine their properties. Let us define the function \( w_i : \mathbb{R}_+ \times \mathbb{R}_+ \to \mathbb{R} \) by

\[
w_i(\tau_i, \tau_j) = m_i(\tau_i) + \delta_i x_i(\tau_j).
\]

(3)

The following result dramatically simplifies the problem.

Proposition 1 Given \( f_j \in \mathcal{F}_j, f_i \in \mathcal{F}_i \) solves the maximization problem (2) and hence \((f_1, f_2)\) is an MPE if and only if for any \( \tau_j \in \mathbb{R}_+ \),

\[
f_i(\tau_j) \in \text{argmax}_{\tau_i \in \mathbb{R}_+} w_i(\tau_i, f_j(\tau_i)).
\]

(4)

Proof. Country 1’s present discounted payoff can be written as

\[
\sum_{t=1}^{\infty} \delta_1^{t-1} [m_1(\tau_{1,t}) + x_1(\tau_{2,t})]
\]

\[
= x_1(\tau_{2,1}) + \sum_{t=1}^{\infty} \delta_1^{t-1} [m_1(\tau_{1,t}) + \delta_1 x_1(\tau_{2,t+1})]
\]

\[
= x_1(\tau_{2,1}) + \sum_{t=1}^{\infty} \delta_1^{t-1} w_1(\tau_{1,t}, \tau_{2,t+1})
\]

\[
= x_1(\tau_{2,1}) + \sum_{t \in T_1} \delta_1^{t-1} (1 + \delta_1) w_1(\tau_{1,t}, \tau_{2,t+1})
\]

\[
= x_1(\tau_{2,1}) + (1 + \delta_1) \sum_{t \in T_1} \delta_1^{t-1} w_1(\tau_{1,t}, f_2(\tau_{1,t})),
\]

(5)

where the third equality follows from \( \tau_{1,t} = \tau_{1,t+1} \) for \( t \in T_1 \). The proposition is now obvious for Country 1. Similarly, we obtain the following equation for Country 2:

\[
\sum_{t=1}^{\infty} \delta_2^{t-1} [m_2(\tau_{2,t}) + x_2(\tau_{1,t})]
\]

\[
= x_2(f_1(\tau_{2,1})) + w_2(\tau_{2,1}, f_1(\tau_{2,1})) + \delta_2 (1 + \delta_2) \sum_{t \in T_2} \delta_2^{t-1} w_2(\tau_{2,t}, f_1(\tau_{2,t})).
\]

(6)

The proposition follows immediately also for Country 2 since the first two terms on the right-hand side of the last equation are exogenously fixed for Country 2. Q.E.D.

Now, we write the set of Country i’s tariff rates that are the best responses to some \( \tau_j \) as \( B_i \equiv \{ f_i(\tau_j) | \tau_j \in \mathbb{R}_+ \} \) Then, we have the following corollary.
**Corollary 1** Suppose \((f_1, f_2)\) is an MPE. Let \(\tau_i, \tau'_i \in B_i\). Then \(w_i(\tau_i, f_j(\tau_i)) = w_i(\tau'_i, f_j(\tau'_i))\).

**Proof.** Since \(w_i(\tau_i, f_j(\tau_i))\) does not depend on \(\tau_j\), the maximized value will not also depend on \(\tau_j\). Thus, Proposition 1 implies that \(\tau_i = f_i(\tau_j)\) yields the same value of \(w_i(\tau_i, f_j(\tau_i))\) for any \(\tau_j\). Q.E.D.

We infer from Proposition 1 and Corollary 1 that level curves of the effective payoff \(w_i(\tau_i, \tau_j)\) plays an important role in finding MPEs. Let us define

\[
D_i(\omega) = \{\tau_i \in \mathbb{R}_+ | w_i(\tau_i, \tau_j) = \omega \text{ for some } \tau_j \in \mathbb{R}_+\}.
\]

Since the lowest payoff for Country \(i\) is zero when \((\tau_1, \tau_2) = (\bar{\tau}_1, \bar{\tau}_2)\) and the highest payoff is \(\bar{\omega}_i \equiv w_i(\tau^N_i, 0)\), it is obvious that \(D_i(\omega) \neq \emptyset\) if \(\omega \in [0, \bar{\omega}_i]\). Now we can define the function \(g^\omega_j : D_i(\omega) \to [0, \bar{\tau}_j]\) by \(w_i(\tau_i, g^\omega_j(\tau_i)) = \omega\) for \(\omega \in [0, \bar{\omega}_i]\). Notice that \(g^\omega_j\) characterizes the \(\omega\)-level curve of \(w_i\) rather than \(w_j\). Figure 1 shows two such level curves of \(w_1\).

The slope of a level curve of \(w_i\), or the graph of \(g^\omega_j\) is readily calculated to be

\[
(g^\omega_j)'(\tau_i) = -\frac{m_i'(\tau_i)}{\delta_i x_j'(g^\omega_j(\tau_i))}.
\]  

It follows immediately that \(g^\omega_j\) is increasing for \(\tau_i < \tau^N_i\), while it is decreasing for \(\tau^N_i < \tau_i < \bar{\tau}_i\). We assume that \(g^w_j(\tau^N_i, \tau^N_j)(0) > 0\), i.e., free trade is preferable for either country to the one-shot Nash equilibrium tariffs. The following lemma will prove to be useful in characterizing the MPE path of tariffs.

**Lemma 1** Consider \(g_1^{w_2(0,0)}\) and \(g_2^{w_1(0,0)}\). In the \((\tau_1, \tau_2)\) space, the graph of the latter is steeper than that of the former at the origin.

**Proof.** We need to show that \((g_2^{w_1(0,0)})'(0) > 1/(g_1^{w_2(0,0)})'(0)\). We see from (7) that this inequality is equivalent to

\[
\frac{m_1'(0)}{x_2'(0)} \frac{m_2'(0)}{x_1'(0)} > \delta_1 \delta_2,
\]
Since \( m_i(\tau_i) + x_j(\tau_i) \) is maximized at \( \tau_i = 0 \), each quotient on the left-hand side is equal to \(-1\). Thus the inequality is satisfied. \( \Box \)

Let \( w_i^*(f) = \max w_i(\tau_i, f_j(\tau_i)) \).

It follows from Proposition 1 that \( w_i^*(f) \) is the MPE payoff for Country \( i \). The following lemma shows that \( \omega' \) in Figure 1, for example, cannot be an MPE payoff for Country 1.

**Lemma 2** Let \( (f_1, f_2) \) be an MPE. Then, \( \tau_i^N \in D_i(w_i^*(f_j)) \).

**Proof.** Suppose to the contrary that \( \tau_i^N \notin D_i(w_i^*(f_j)) \). If \( w_i^*(f_j) \geq w_i(\tau_i^N, \bar{\tau}_j) \) and of course \( w_i^*(f_j) \leq \bar{\omega}_i \), then there exists \( \tau_j' \leq \bar{\tau}_j \) such that \( w_i^*(f_j) = w_i(\tau_i^N, \tau_j') \), meaning that \( \tau_i^N \in D_i(w_i^*(f_j)) \), thus \( w_i^*(f_j) < w_i(\tau_i^N, \bar{\tau}_j) \). Since \( x_i \) takes the lowest value at \( \bar{\tau}_j \), we have \( w_i^*(f_j) < w_i(\tau_i^N, \bar{\tau}_j) \leq w_i(\tau_i^N, f_j(\tau_i^N)) \), which contradicts the definition of \( w_i^* \) that \( w_i^*(f_j) = \max w_i(\tau_i, f_j(\tau_i)) \). \( \Box \)

The next lemma shows how the function \( g_i^\tau \) is used to construct MPE strategies.

**Lemma 3** Let \( (f_1, f_2) \) be an MPE. Then, \( f_j(\tau_i) \geq g_j^{w_i^*(f_j)}(\tau_i) \) with equality for at least one \( \tau_i \in \mathbb{R}_+ \).

**Proof.** Suppose to the contrary that \( f_j(\tau_i') < g_j^{w_i^*(f_j)}(\tau_i') \) for some \( \tau_i' \). Then, since \( w_j \) is decreasing in the second argument, we have \( w_i(\tau_i', f_j(\tau_i')) > w_i^*(f_j) \). A contradiction to the definition of \( w_i^* \). Next suppose that \( f_j(\tau_i) > g_j^{w_i^*(f_j)}(\tau_i) \) for all \( \tau_i \). Then we obtain \( \max w_i(\tau_i, f_j(\tau_i)) < w_i^*(f_j) \). This contradicts that \( w_i^*(f_j) \) is an MPE payoff. \( \Box \)

Let \( E_i(f_j) = \{ \tau_i \in \mathbb{R}_+ | w_i(\tau_i, f_j(\tau_i)) = w_i^*(f_j) \} \).

Country \( j \)'s MPE strategy \( f_j(\tau_i) \) coincides with \( g_j^{w_i^*(f_j)}(\tau_i) \) if and only if \( \tau_i \in E_i(f_j) \). That is, \( E_i(f_j) \) is the set of Country \( i \)'s tariffs that may be selected in an MPE outcome. Notice that \( E_i(f_j) \subseteq D_i(w_i^*(f_j)) \). The following proposition completely characterizes MPE.
Proposition 2 \((f_1, f_2)\) is an MPE if and only if \(B_i \subseteq E_i(f_j)\).

Proof. The proposition follows immediately from Proposition 1. \(\text{Q.E.D.}\)

Figure 2 shows an example of an MPE. Notice that \(E_1(f_2)\) includes an isolated point due to a jump in Country 2’s MPE strategy, while \(E_2(f_1)\) is an interval. Another example is \((f_1, f_2)\) such that \(f_i(\tau_j) = \tau_i^N\) for any \(\tau_j \in \mathbb{R}_+\). In this MPE with infinite repetition of the individual countries’ Nash equilibrium tariffs, we have that \(B_i = E_i(f_j) = \{\tau_i^N\}\).

As these examples suggest, there are infinitely many MPEs. Some of them Pareto dominate some others. The following lemma helps us find Pareto efficient MPEs.

Lemma 4 Let \((f_1, f_2)\) be an MPE. Then the graphs of \(g_1^{w_i^1(f_2)}\) and \(g_2^{w_i^1(f_2)}\) have at least one intersection.

Proof. Suppose to the contrary that these graphs do not intersect with each other. Then it is easy to see that the graph of \(g_1^{w_i^1(f_1)}\) lies entirely above that of \(g_2^{w_i^1(f_2)}\) in the \((\tau_1, \tau_2)\) space, and hence either \(0 \not\in D_1(w_i^1(f_2))\) or \(0 \not\in D_2(w_i^1(f_1))\). Let us suppose \(0 \not\in D_1(w_i^1(f_2))\) as Figure 3 depicts for the sake of concreteness. Defining \(\tau_1^1 = \min D_1(w_i^1(f_2))\), it follows from Proposition 2 that \(\min B_1 \geq \tau_1^1\). This in turn means that \(\min E_2(f_1) \geq (g_1^{w_i^2(f_1)})^{-1}(\tau_1^1) \equiv \tau_2^2 > 0\) as Figure 3 shows. Then it implies \(\min B_2 \geq \tau_2^2\), implying that \(\min E_1(f_2) \geq (g_2^{w_i^1(f_2)})^{-1}(\tau_2^2) \equiv \tau_1^3 > \tau_1^1\). This process continues, without converging to a tariff profile, until for some \(i\), \(\min E_i(f_j)\) is to be greater than \((g_i^{w_i^j(f_j)})^{-1}(\tau_j^N)\). (In Figure 3, \(i = 2\) and \(\min E_i(f_j) = \tau_2^6\)). Then it follows that \(g_i^{w_i^j(f_j)}(\tau_j) < \min E_i(f_j)\) for any \(\tau_j \in D_j(w_j^i(f_i))\). Together with Lemma 3, however, this implies that \(B_i\) includes some \(\tau_i\) outside of \(E_i(f_j)\), which is a contradiction to Proposition 2. \(\text{Q.E.D.}\)

The following corollary states that if there exists the tariff profile \((\tau'_1, \tau'_2)\) such that the graph of \(g_1^{w_i^2(f_1)}\) lies above that of \(g_2^{w_i^1(f_2)}\) on \([0, \tau'_1] \times [0, \tau'_2]\), Country \(i\) will not select any \(\tau_i \in [0, \tau'_i]\) in MPE.
Corollary 2 If there exists \((\tau'_1, \tau'_2)\) such that \(g^*_w(j)(\tau'_j) = \tau'_i\) for \(i = 1, 2\) and \((g^*_w(f_i))^{-1}(\tau_1) > g_2(\tau_1)\) on \(\{\tau_1 \in D_1(w^*_1(f_2))|\tau_1 < \tau'_1\}\), then \([0, \tau'_i) \not\subset E_i(f_j)\).

Proof. The same logic as in the proof of Lemma 4 applies. Q.E.D.

4 Pareto Efficient Markov Perfect Equilibrium

Although there are multiple MPEs, some MPEs Pareto dominate some others. In this section, we derive Pareto efficient MPEs and examine their properties.

Let \(v_i(\tau_2, f_1, f_2)\) denote the present discounted MPE payoff for Country \(i\). It follows from (5) and Corollary 1 that the present discounted MPE payoff for Country 1 can be written as

\[
v_1(\tau_2, f_1, f_2) = x_1(\tau_2) + (1 + \delta_1) \sum_{t \in T_1} \delta_t^{-1} w_1(f_1(\tau_2), f_2 \circ f_1(\tau_2)) = x_1(\tau_2) + \frac{1}{1 - \delta_1} w_1^*(f_2)
\]

Similarly, it follows from (6) that

\[
v_2(\tau_2, f_1, f_2) = x_2(f_1(\tau_2)) + w_2(\tau_2, f_1(\tau_2)) + \frac{\delta_2}{1 - \delta_2} w_2(f_2 \circ f_1(\tau_2), f_1 \circ f_2 \circ f_1(\tau_2)) = x_2(f_1(\tau_2)) + w_2(\tau_2, f_1(\tau_2)) + \frac{\delta_2}{1 - \delta_2} w_2^*(f_1)
\]

Moreover, we will see that \(w_2(\tau_2, f_1(\tau_2)) = w_2^*(f_1)\) if \(\tau_2\) is large enough, to which case we pay most attention.

Therefore, the higher \(w_1^*(f_2)\) the more preferable is \(f_2\) for Country 1, and the higher \(w_2^*(f_1)\) the more preferable is \(f_1\) for Country 2.

Proposition 3 \((f_1, f_2)\) is a Pareto efficient MPE if and only if the graphs of \(g^*_w(f_1)\) and \(g^*_w(f_2)\) are tangent to each other and

\[
f_i(\tau_j) = \begin{cases} 
g^*_w(j)(\tau_j) & \text{if } \tau_j \geq \tau^*_j \\
\tau^*_i & \text{if } \tau_j < \tau^*_j
\end{cases}
\]
where \((\tau_1^*, \tau_2^*)\) is the tangency point.

**Proof.** The proposition follows immediately from Lemma 4, Corollary 2, and that \(g_i^w\) shifts down as \(w\) increases. Q.E.D.

Figure 4 depicts a Pareto efficient MPE. It also shows the equilibrium sequence of tariffs from \(\tau_2^N\). As indicated in the figure, both countries gradually decrease their individual tariffs if \(\tau_{2,1}\) is higher than \(\tau_2^*\). (Notice that in this case \(w_2(\tau_{2,1}, f_1(\tau_{2,1})) = w_2^*(f_1)\).) Figure 4 depicts the tariff sequence in the case where \(\tau_{2,1} = \tau_2^N\). If the initial tariff \(\tau_{2,1}\) is smaller than \(\tau_2^*\), on the other hand, the countries come to select \((\tau_1^*, \tau_2^*)\) very soon and continue to select this profile thereafter.

Lemma 1 implies that the contract curve with regard to the effective payoffs will not pass through the origin unless in the limit case where \(\delta_i\) approaches one for \(i = 1, 2\). In this limit case, as Figure 5 shows, each country continues to lower its tariff rate so that the tariff profile converges to \((0,0)\). We record these findings as the final proposition.

**Proposition 4** If the initial tariff rate for Country 2 is large, each country continues to lower its tariff rate. Except in the limit case where both countries do not discount the future, however, countries will not enter the phase of free trade.

5 Concluding Remarks

We have analyzed a tariff-setting game between two large countries, in which countries alternate in setting their individual tariffs. We have found that there are multiple Markov perfect equilibria in which countries gradually decrease their individual tariff rates even without a punishment scheme. Except in the limit case where countries do not discount the future, however, even Pareto efficient MPE will not induce countries to completely eliminate their tariffs. Countries unilaterally cut their individual tariffs since they believe correctly
that it is to be reciprocated by the other country. An implicit promise to reciprocate the tariff reduction serves as a reward to the unilateral tariff reduction.

It can be shown that there also exist multiple mixed-strategy equilibria. In some mixed-strategy equilibria, free trade will be attained some time in the future with probability one. In such equilibria, countries select zero tariffs with probability one if the other country’s current tariff rate is zero. Therefore, the tariff profile will not escape from \((0,0)\) once free trade is attained. The corresponding \(u^*_j(f_i)\) to this mixed strategy MPE is the one whose graph passes through the origin. As we have seen, however, unless in the limit case where countries do not discount the future, there exists an MPE that Pareto dominates this mixed strategy MPE. Thus, moving towards free trade need not be most favorable.
References


Figure 1. Examples of $D_1(\omega)$
Figure 2. An MPE
Figure 3. The Case in which MPEs cannot be constructed
Figure 4. A Pareto Efficient MPE
Figure 5. An MPE path Leading to Free Trade