Long-Run Consequences of Trade Talks when Governments are not Hyper-Rational

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Abstract

I analyzed the long run consequences of "free trade versus protection" game with adaptive learning. I assumed that governments are less rational and have less information than usually assumed in a traditional model, and used a concept of Young's (1998) "stochastically stable states". A major result is that if political influences of import-competing industries are small, or if punishment to violating obligation of the trade agreement is severe enough, then the free trade regime is likely to be observed over the long run in most cases.

Motivation

Fans and foes of globalization usually agree on one thing: its inevitability. But that is a big mistake… (The economist (Jan. 8th-14th 2000))

The path toward trade liberalization has never been flat. According to O'Rourke and Williamson (1999) reviewed in the above economist magazine, the first great globalization which lasted from 1840 to 1914 increased the world trade volume dramatically, but it was followed by a protectionist regime prior to World War II. The losers from globalization triggered a political backlash against free trade. Under the GATT / WTO system after WWII, tariff levels were drastically reduced. However, accompanying the success in reducing baseline tariffs, there emerged much controversy on non-tariff barriers, managed trades (e.g. Voluntary Export Restraint), aggressive unilateralism (e.g. Section 301) and so on. There always seem to be a risk of protectionism. In this paper, I will analyze the conditions under which free trade or protectionism emerges as long-run regimes.

Among the models on the role and design of an international trade agreement, the most intensively used one is the model with a repeated game. In a one-shot game, countries have unilateral incentives to deviate from free trade and choose Nash equilibrium tariffs. In the subgame perfect equilibrium of the repeated game, however, the deviating country receives retaliation from a rival country and this threat of future punishment induces countries to stick to cooperative tariffs. In this setup, governments are rational in the sense that they know their own and their rivals' payoffs and that they have a long run perspective and compare the one time benefits from deviation with the discounted value of cost caused by future trade war[1].

In this paper, I will adopt a different approach. In my approach, governments are not hyper-rational and are not necessarily informed on the opponents' payoffs (even on the distribution of the parameters in the rivals' payoff functions). They might not even know

[1] There are some models of international trade agreements in which players have some limited information. Among them, Hungerford (1991) deals with the governments that cannot observe their rivals' non-tariff barriers, and Bac and Raff (1994) considers countries that are privately informed on their types (tough or

their own future payoffs, since these might change as time goes on. As a result, they do not care about the future and choose their actions based on the history of opponents' actions. Once in a while, in addition, they might make errors and choose actions at random[2]. I will adopt an adaptive learning model illustrated by Young (1998). A major conclusion is that if import-competing sectors in one or both of the two countries which belong to an international trade agreement get politically influential, or if punishment on protectionism allowed by the trade agreement is not severe enough, then protectionism is likely to be observed over the long run.

Methodology and Model

(Basic Setup: Bagwell and Staiger Model)

I will adopt Young's (1998) adaptive learning model in this paper: Governments choose their actions based on the observation of the history of their rivals' actions. Before doing that, I will construct a basic trade model following Bagwell and Staiger (1990, 1993a, 1993b) and Staiger (1995).

Their model is a two country two good model. Domestic country (no *) is endowed with 3/2 units of good 1 and 1/2 of good 2, and foreign country (*) is endowed with 1/2 of good 1 and 3/2 of good 2. Each country wants to consume both goods symmetrically through trade. As a result, the domestic (foreign) country exports good 1 (2) and imports good 2 (1). Demand functions are assumed to be symmetric across goods and countries, and independent of prices of other goods. Specifically, they are assumed to have the same functional form: $C(P) = \alpha - P$. Domestic country levies an import tariff t_m on good 2, and foreign country levies an import tariff t_m^* on good 1. Thus, letting P_x be the export price of good 1, we can represent the import price of good 1 as $P_m^* = P_x + t_m^*$. And the export price of good 2 is P_x^*, and its import price is $P_m = P_x^* + t_m$. The equilibrium export price of good 1 is determined by the equation "world supply = world demand":

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soft) in negotiations. But the players in these models are more rational than those in my model shown below.

[2] These observations are based on my personal experience when I was working in Japanese government.

$3/2+1/2=\alpha-P_x+\alpha-(P_x+t_m^*)$, which yields $\hat{P}_x(t_m^*)=\alpha-1-t_m^*/2$. The "hat" denotes equilibrium. The equilibrium import price of good 1 is then $\hat{P}_m^*(t_m^*)=\alpha-1+t_m^*/2$ and the volume of good 1 imported by foreign country is $\hat{M}^*(t_m^*)=1/2-t_m^*/2$. Similarly, at equilibrium, the export price of good 2 is $\hat{P}_x^*(t_m)=\alpha-1-t_m/2$, the import price of good 2 is $\hat{P}_m(t_m)=\alpha-1+t_m/2$, and the volume of good 2 imported by domestic country is $\hat{M}(t_m)=1/2-t_m/2$. To focus on inner solutions and exclude prohibitive tariffs, I assume t_m, $t_m^* \in [0,1)$.

Next, I define the domestic government's objective function:

$$W(t_m,t_m^*)=\int_{\hat{P}_m(t_m)}^{a} C(P)dP+\int_{\hat{P}_x(t_m^*)}^{a} C(P)dP+r\int_0^{\hat{P}_m(t_m)} 1/2dP+\int_0^{\hat{P}_x(t_m^*)} 3/2dp+t_m\hat{M}(t_m) \quad (1)$$

The first and second terms represent consumer surpluses, the third one is the import-competing industry's producer surplus, the fourth one is the export sector's producer surplus, and the fifth is tariff revenue. A weight on the third term, r, comes from a political economy argument. If the import-competing industry lobbies the government and has much political influence, then r becomes larger than 1.[3]

Similarly, the foreign government's objective function is:

$$W^*(t_m,t_m^*)=\int_{\hat{P}_m^*(t_m^*)}^{a} C(P)dP+\int_{\hat{P}_x^*(t_m)}^{a} C(P)dP+r^*\int_0^{\hat{P}_m^*(t_m^*)} 1/2dP+\int_0^{\hat{P}_m^*(t_m)} 3/2dp+t_m^*\hat{M}^*(t_m^*) \quad (2)$$

First order condition for domestic government's welfare maximization $\partial W(t_m,t_m^*)/\partial t_m=0$ yields $t_m^N=r/3$. Note that this optimal tariff for the domestic government is independent of the foreign government's tariff level or the political influence of import-competing sector in the foreign country, r^*. This comes from the assumption that a demand for one good is independent of the price of the other good.

[3] Social welfare and the government's welfare do not necessarily match. Thus, a small r does not imply that the import-competing industry is not important from a social respect.

Thus, this optimal tariff is equal to the tariff chosen in Nash equilibrium of this one-shot game. To ensure inner solutions, again, we assume that r < 3. Similarly, first order condition for the foreign government's welfare maximization yields $\boldsymbol{t}_m^{*N} = r^* / 3$.

(Payoffs in a "Free Trade versus Protection" Game)

Bagwell and Staiger are considering an infinitely repeated game using the above setup, but I will adopt a different approach. The rule of the game in this paper is assumed to be as following: At the beginning of every period (t = 1,2,3…), each government chooses one of the two choices: Free trade (F) or Protection (P). If it chooses F, it must set its tariff level to zero immediately. If it selects P, it chooses its Nash equilibrium tariff derived in the last section. It is assumed that there is no time lag between making the binary decision and setting its tariff level[4]. Then, consumption in the two countries and trade between them take place[5].

The two countries' payoff matrix is

		Foreign Country: F		Foreign Country: P	
Domestic Country	F	W_{FF}	W_{FF}^*	W_{FP}	W_{FP}^*
	P	W_{PF}	W_{PF}^*	W_{PP}	W_{PP}^*

where

$$W_{FF} = W(0,0) = (r/2 + 3/2)(\boldsymbol{a} - 1) + 1$$

$$W_{FP} = W(0, r^*/3) = -(1/72)r^*(6 - r^*) + (r/2 + 3/2)(\boldsymbol{a} - 1) + 1$$

$$W_{PF} = W(r/3, 0) = r^2/24 + (r/2 + 3/2)(\boldsymbol{a} - 1) + 1$$

$$W_{PP} = W(r/3, r^*/3) = r^2/24 - (1/72)r^*(6 - r^*) + (r/2 + 3/2)(\boldsymbol{a} - 1) + 1 \qquad (3)$$

[4] This is assumed to avoid a problem of time-inconsistency that emerges when a government selects F but chooses a Nash equilibrium tariff.

[5] There are two assumptions to simplify the story: Choices are binary (F or P), and if a country selects F, then it sets its tariff to zero (not a cooperative tariff level). The latter assumption also comes from the assumption that each player does not know the rival's payoff . This point will be discussed later.

and

$$W^*_{FF} = W^*(0,0) = \left(r^*/2 + 3/2\right)(\alpha - 1) + 1$$

$$W^*_{FP} = W^*(0, r^*/3) = r^{*2}/24 + \left(r^*/2 + 3/2\right)(\alpha - 1) + 1$$

$$W^*_{PF} = W^*(r/3, 0) = -(1/72)r(6 - r) + \left(r^*/2 + 3/2\right)(\alpha - 1) + 1$$

$$W^*_{PP} = W^*(r/3, r^*/3) = r^{*2}/24 - (1/72)r(6 - r) + \left(r^*/2 + 3/2\right)(\alpha - 1) + 1 \qquad (4)$$

Note that $W_{FF} > W_{PP}$ does not necessarily hold, since we assumed that a country that selected F must choose a zero tariff (not a cooperative tariff). However, this inequality holds for a wide range of parameters and we assume that it actually does, since it is natural (though this is not a critical assumption). Thus, the sum of the first and second terms in the fourth equation in (3) and (4) is usually assumed to be negative.

It is clear that protection (P) is a strictly dominant action for both players, and (P, P) becomes a Nash equilibrium. This is a typical "prisoner's dilemma" case.

(Introduction of external punishment)

The story in the period does not end at this point. Both of the two countries belong to an international trade agreement. If a country chooses F but the other selects P, then some units of punishment are assumed to be levied on the country that selected P according to the rule of this agreement. Setting a zero tariff (Free Trade) is obligation to the member countries in the agreement, but since there is no international police or prison, if a country does not find adherence to the principle as in its interest, it might deviate from free trade and chooses Nash equilibrium tariff (Protection). The punishment is levied on this deviator.

The possible interpretation of this punishment in this model is as follows: (1) Retaliation by the other country in a different field (good) [6]. (2) "Psychic" cost that

[6] Dispute settlement procedure of WTO allows retaliation in a different field, although that of GATT did not. But since retaliation with the same good is still a general principle, the setup in this model might be unrealistic. An episode of retaliation under GATT is found in 1952 when the Netherlands appealed to the GATT panel against the U.S.

emerges from the fact that "only my country violated the international obligation" [7]. (3) Punishment from a third party.

The retaliation by the other country can be formalized as following. If, for example, the domestic country chooses F, and the foreign country selects P, then the domestic country is allowed by the agreement to adopt a retaliatory high tariff (Nash tariff) within the same period t. Unless the trade agreement allows, each country is assumed to be prohibited from changing its trade policy from the one it announced at the beginning of the period. Then the payoff of the domestic country becomes

$(1-\delta)W_{FP}+\delta W_{PP}=W_{FP}+\delta(W_{PP}-W_{FP})$.

The payoff of the foreign country becomes

$(1-\delta^*)W^*_{FP}+\delta^* W^*_{PP}=W^*_{FP}-\delta^*(W^*_{FP}-W^*_{PP})$.

δ and δ^* reflect the length of the punishment within this period and the social rate of time preference in each country. In addition, letting the psychic cost and the punishment from third party be x_2 and x_3 respectively for the domestic country (x_2^* and x_3^* for the foreign country), the payoff matrix becomes

		Foreign Country: F		Foreign Country: P	
Domestic Country	F	W_{FF}	W^*_{FF}	W_{FP}'	W^*_{FP}'
	P	W_{PF}'	W^*_{PF}'	W_{PP}	W^*_{PP}

where

$$W_{FP}'=W_{FP}+\delta(W_{PP}-W_{FP})=(r/2+3/2)(\alpha-1)+1-(1/72)r^*(6-r^*)+\delta r^2/24$$

$$W^*_{FP}'=W^*_{FP}-\delta^*(W^*_{FP}-W^*_{PP})-x_2^*-x_3^*=(r^*/2+3/2)(\alpha-1)+1-\delta^*(1/72)r(6-r)+r^*/24-x_2^*-x_3^*$$

$$W_{PF}'=W_{PF}-\delta(W_{PF}-W_{PP})-x_2-x_3=(r/2+3/2)(\alpha-1)+1-\delta(1/72)r^*(6-r^*)+r^2/24-x_2-x_3$$

$$W^*_{PF}'=W^*_{PF}+\delta^*(W^*_{PP}-W^*_{PF})=(r^*/2+3/2)(\alpha-1)+1-(1/72)r(6-r)+\delta^* r^{*2}/24. \quad (5)$$

[7] This point is discussed in Staiger (1995) pp.1526.

For the remainder of this paper, the punishment parameters x_2, x_3, x_2^*, x_3^*, δ, and δ^* are externally given by the international trade agreement and assumed be in such range that two Nash equilibria ((F, F) and (P, P)) emerge: That is

$\delta(1/72)r^*(6-r^*)+x_2+x_3 > r^2/24$ and $\delta^*(1/72)r(6-r)+x_2^*+x_3^* > r^{*2}/24$. This creates a situation like "eye for eye, and teeth for teeth". Every player wants to take the same action as the opponent's. A big problem that arises at this moment is how each country infers the action that its rival will choose, since they must choose their actions simultaneously. Next section explains this.

An important point is that these punishment parameters are given externally in my model unlike the repeated game in which the kind of punishment is incorporated in a part of a subgame perfect equilibrium (most typically an infinite Nash reversion). The process of determining those parameters is beyond the scope of my paper. In the "results" section, I will consider what situation is most likely to emerge over the long run as the parameters like r change, given the levels of the punishment parameters [8]. Before doing so, I will explain how the two players infer the rival's actions.

(Adaptive Learning)

In this section, I will describe the rule according to which each country chooses its action: Free trade (F) or Protection (P).

In a traditional repeated game, each country chooses its action comparing the one-time payoff obtained from withdrawal from free trade with the discounted cost of future trade wars triggered by this deviation. In my model, however, each government cares about only the payoff generated in the current period t and is assumed to use adaptive learning to infer the rival's action. I will explain the rule of the game first and then the intuition behind it.

First, the domestic country calculates threshold value β with which the foreign country selects F making the domestic country indifferent between selecting F and P:

[8] An interpretation for this externality of x is that these two countries are small members in this agreement and do not have enough power to alter its rule.

$W_{FF}\beta + W_{FP}'(1-\beta) = W_{PF}'\beta + W_{PP}(1-\beta)$. This equation boils down to

$$\beta = \frac{W_{PP} - W_{FP}'}{W_{FF} - W_{FP}' - W_{PF}' + W_{PP}} = \frac{(1-\delta)(r^2/24)}{\delta\left[(1/72)r^*(6-r^*) - r^2/24\right] + x_2 + x_3} \qquad (6).$$

The second equality comes from (3) and (5). The domestic country will choose F, if it infers that the foreign country will select F with a possibility greater than β. Similarly, the threshold value for the foreign country is

$$\beta^* = \frac{W_{PP}^* - W_{PF}^{*\prime}}{W_{FF}^* - W_{PF}^{*\prime} - W_{FP}^{*\prime} + W_{PP}^*} = \frac{(1-\delta^*)(r^{*2}/24)}{\delta^*\left[(1/72)r(6-r) - r^{*2}/24\right] + x_2^* + x_3^*} \qquad (7).$$

Now we are entering the core part of the assumptions in this paper: Each country adopts an adaptive learning of Young (1998) with memory *m*, sample size *s*, and error rate *e*, to infer which action the rival is likely to take:

- With probability of *1-e*, the domestic country draws a sample of size s from the set of actions[9] taken by the foreign government over the last m periods. Then the domestic government observes the proportion of F in the sample and infers the probability with which the foreign government will choose F. If this ratio is larger (smaller) than β, then the domestic government thinks that its rival is likely to select F (P), and chooses F (P) (eye for eye). If the ratio is equal to β, then the domestic government chooses F or P at random (tie-breaking rule). If it selects F (P), then it sets the tariff rate to zero (r/3) immediately.
- With probability *e*, the domestic country commits an error and selects F or P at random (with the same probability 0.5).
- The foreign government behaves in a similar manner at the same time. Its memory m, sample size s, and error rate e are assumed to be the same as those of the domestic government. Its threshold value is β^* instead of β. The errors occur and the samples are drawn independently of the domestic player's behavior.

Next, I will explain the intuition behind the above "adaptive learning".

[9] In this context, actions in the sample are binary, F or P, but do not include the tariff *levels* selected by the foreign government after it chose P. This is assumed partly for convenience and partly because the governments are not rational enough to take the opponent's tariff *levels* into account to infer the rivals' next action.

The governments care only the payoffs generated in the current period t, because they are short-sighted. They are not sure if they will remain in their incumbent position next period. (Suppose that the decision-maker in each government is randomly chosen from a number of staff each period.) Moreover, they cannot predict even their own payoffs in the future, since some of the parameters might change drastically.

The governments use samples to infer the rival's next action, because they are less-informed and less rational than assumed in traditional models. The domestic government, for example, is assumed to know all the parameters in its own payoffs including r^* and be able to calculate the payoffs, but might not know δ^* or x_2^*[10]. Thus, it cannot calculate the foreign government's payoffs and has to depend upon the history of the past actions to infer the foreign government's next action. However, if the domestic government were more rational, then it would take different approach: Suppose that r^* increased drastically. After observing it, the rational domestic government would think that the probability of the foreign government's choosing F became higher. This does not happen in my model: The domestic government gives up to calculate the foreign government's payoffs, because it does not know δ^* or x_2^*, and depends upon the sampling. The foreign government behaves in the same manner.

The governments choose the best action based on the sampling. This is called "best-reply" dynamics. Some evolutionary models deal with "better-reply" dynamics [11]. In these models, players are assumed even less rational than in my model. They sometimes do not know even their own payoffs. But I do not adopt this approach, because I think that many people (consumers and workers) are involved in my trade game and the governments are more serious than adopt such dynamics.

The governments sometimes make mistakes. In the actual trade talks between governments, it is not likely to happen that a government official makes a careless

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[10] r^* represents relationship between the government and the import-competing sector in the foreign country. δ^* reflects the subjective time-preference of the foreign government. The former is considered more likely to be observable. In my model, the domestic government cannot calculate its own payoffs without the information of the former parameter, so the observability of this parameter is required. If we exclude the possibility of the first punishment (retaliation by the rival) and focus on *x's*, then the story becomes more simple: We can assume that the players adopt adaptive learning because they do not know the rivals' *r*.

[11] See Friedman and Mezzetti (1999).

mistake like signing his or her name in a wrong place in a document. Possible interpretations of the errors are: First, the case in which the government representative observes its own parameter *r* precisely, but has a belief on which action the foreign rival will take without drawing a sample. (This belief might come from his or her personal prejudice about the opponent country). In this case, if the government happens to select P, then it sets the tariff to r/3. Second, the case in which the government official has a special personal interest in protecting the import-competing sector. If the representative likes the sector, he or she will choose P and select a Nash tariff. If he or she hates the sector personally, he or she will choose F.

There is one thing I should note here: The above trade talk in a period is not a "negotiation" because there is no room to change its own action in response to the rival's action during this period. Before facing each other at the same table, each country has already decided its action based on a sample or a prejudice, and it will never alter this decision at the table. This trade talk is held only to reveal the players' actions and comes to adjournment right after opening[12]. In this sense, we cannot call the result of the trade talk an "agreement". Over many periods, however, the players adjust their actions gradually in response to the rival's actions.

The above procedure is repeated for a long time (t = 1, 2, 3…). The evolution of this game is represented by a "state". A state at period t is defined as the players' history of actions with length m. For example, if m = 6, then a state at period t might be

t-5, t-4, t-3, t-2, t-1, t	
P F P P P F	domestic country
P F F P F F.	foreign country

In this case, the domestic country chose F at t, P at t-1, P at t-2, and so on.
Given this state, the domestic country will draw a sample of size s from PFFPFF with probability 1-e at period t+1 and determines its action. If the domestic country chose F and the foreign country chose P at period t+1, then the state at t+1 becomes

[12] If a period (t) is interpreted as a round of GATT, this setup is never plausible. There are some papers focusing on why trade negotiation in a round takes long (see Bac and Raff (1994) and Staiger (1995)).

F P P P F F
F F P F F P.

Please note the left column was erased and a new column was added to the right. At t = 0, a state is given externally. The above process is summarized in Table 1.

Results (Stochastic Stable Outcomes)

In this section, I will illustrate what happens as a result of the above procedure of the game. To do it, first, I will define a "risk-dominant" outcome of the one-shot game shown by 2 * 2 payoff matrix before. This one-shot game (let's denote it G) had two Nash equilibria: (F, F) and (P, P). Such a game with two (pure strategy) equilibria is called a coordination game. Equilibrium (F, F) is defined to be risk dominant if

$$(W_{FF} - W_{PF}')(W_{FF}^* - W_{FP}^{*\prime}) \geq (W_{PP} - W_{FP}')(W_{PP}^* - W_{PF}^{*\prime}). \qquad (8)$$

Intuitively, it implies that deviating from (F, F) is more risky than deviating from (P, P). Note that this is a concept with the two countries taken together: even if deviating from (F, F) is not so risky for the domestic country, if it is much risky for the foreign country, then (F, F) might become risk dominant. Similarly, (P, P) is risk dominant if the reverse inequality holds (Harsanyi and Selten (1988) and Young (1998, pp.66)). Using (3), (4), (5), and a little algebra, (8) becomes

$$\left[\delta(1/72)r^*(6-r^*) - r^2/24 + x_2 + x_3\right]\left[\delta^*(1/72)r(6-r) - r^{*2}/24 + x_2^* + x_3^*\right] \geq (1-\delta)(r^2/24)(1-\delta^*)(r^{*2}/24) \qquad (9)$$

Thus, we get a lemma:

Lemma

In our "free trade versus protection" game with adaptive learning, if x's or deltas (punishment to deviation from free trade levied by the agreement) are larger, then (F, F) (free trade Nash equilibrium) is more likely to be risk dominant. If r or r^* (a political influence of import-competing industries) is smaller, then (F, F) is more likely to be risk dominant <u>in most cases</u>.

The effect of r (r^*) on (9) is complex. If r decreases, the first bracket on the left hand side increases and the right hand side decreases. This reflects that the domestic government puts less emphasis on protecting the domestic import-competing sector (this reduces β). This effect is natural. At the same time, however, decrease of r reduces the second bracket. This is because the threat of retaliation by home against foreign becomes less serious for the foreign with a decreased Nash tariff $r/3$ (this raises β^* and makes the foreign closer to a protectionist). To make sure this effect, see $W_{FP}^{*}{}'$ in (5). In most cases, the former effect outweighs the latter, and smaller r makes (F, F) close to risk dominant. However, in some exceptional cases, in which r is close to zero and r^* is extremely high, the latter dominates the former, and the decline of r might cause (P, P) to be risk dominant, contrary to the most cases. (To make sure this, take a derivative of both hands in (9) with respect to r.) This phenomenon is interesting. If the domestic country is an extreme free trade advocate, a further decrease of r will not affect its own behavior so much anymore, but reduce the threat of retaliation the foreign government faces. This induces the foreign country to choose P and might make (P, P) risk dominant. For example, suppose $\alpha = 2$, $r = 0.18$ (very low), $r^* = 2.7$ (very high), $\delta = \delta^* = 0.3$, $x_2 + x_3 = x_2^* + x_3^* = 0.3$. Then the criterion of risk-dominance (9) is 0.000207>0.000201, and (F, F) is slightly risk dominant. If r declines to 0.17, the criterion becomes 0.000128<0.000179, and (P, P) becomes risk dominant. Similar argument holds even if we exchange r and r^*.

Next, we consider which state is stochastically stable in our repeated trade game. The formal definition of "stochastically stable" is given in Young (1998). Intuitively, stochastically stable states are the states that are most likely to be observed over the long run when e (error rate) is sufficiently small (Young (1998) pp.55).

In our repeated trade game, there exist many states, among which the states that cannot transform to other states once locked in when e = 0 and contain only one action are called conventions. One of them is

FFF…F
FFF…F.

We call it a "free trade regime". If this is the state at period t, then the both countries will choose F at t+1 unless they make errors, since any samples drawn from their rivals' past

actions do not contain P, and F is the best reply to any of these samples. There is only one more convention in our model:

PPP…P
PPP…P,

which we call a "protectionist regime". If (F, F) is risk dominant, then the former convention is called a risk-dominant convention.

In Young (1998), it is shown that under some conditions the risk-dominant convention is equivalent to the stochastically stable state:

Theorem

*Let G be a 2*2 coordination game, and* $P^{m,s,e}$ *be adaptive learning with memory m, sample size s, and error rate e. If information is sufficiently incomplete (s/m ≤ ½), and s and m are sufficiently large, the stochastically stable states of the perturbed process correspond one to one with the risk-dominant conventions (Young (1998), pp.68)* [13].

Using this theorem and the above lemma, we can derive next proposition:

Proposition

In our "free trade versus protection" trade game with adaptive learning, the larger the x's or deltas (punishment to protection) are, the free trade regime tends to become the risk-dominant convention. The smaller the r or r^* *(import-competing sectors' political influence) is, the free trade regime tends to become the risk-dominant convention in most cases. If the free trade regime is risk dominant, information is sufficiently incomplete (s/m ≤ ½), and s and m are sufficiently large, then the free trade regime corresponds one to one with the stochastically stable state and is likely to be observed over the long run.*

First, we consider the above "most" cases. That is, r and r^* are within normal ranges and smaller values of them induce the free trade regime. Note from (9) that even if the

[13] "Perturbed" means e > 0. The formal proof of this theorem is given in Young, but the essence of it is: The stochastically stable state is the convention which has the smallest *resistance* (the number of errors required for transforming the other convention to itself). That a convention has the smallest resistance and that the Nash equilibrium which corresponds to the convention is risk dominant are the same thing if s is large. This logic derives the theorem.

foreign country has a somewhat large r^* and has a tendency to resort to protectionism, if the domestic country has an r small enough to offset it, then the free trade regime is likely to be observed. This is because the domestic country has a great tendency to choose free trade, its actions are recorded in history, and the foreign country observes it, updates its beliefs, and adjusts its actions in response to it. To put in a pessimistic way, even if a country tends to select free trade, if the other has a great tendency to choose protection, then the protectionist regime will be likely to emerge. It is another side of the same coin.

Even if both r *and* r^* are large, if the punishment is severe enough, then free trade regime tends to be observed. Although the mechanism which determines the level of x's and deltas is beyond the scope of this paper, if x's and deltas are sufficiently high, then two countries have incentives to join this international trade agreement. Recall that W_{FF} (W^*_{FF}) is assumed to be larger than W_{PP} (W^*_{PP}), so the countries prefer the free trade regime to the protectionist regime.

The above "exceptional" cases are worth considering. Suppose the domestic country is an extreme free trade supporter but the foreign is an extreme protectionist. Suppose the risk dominant criterion favors (F, F) by margin and the free trade regime is stochastically stable. Then, if the domestic country puts further less emphasis on its own import-competing industry, this might reduce the threat of retaliation the foreign government faces and might make the protectionist regime stochastically stable. This reminds me of a famous Japanese proverb "Too much is the same thing as too little".

Simulation

I did a simulation using the above "most case" setup: that is, both of r and r^* do not take on extreme values. All through the simulation (t = 1 – 400), I assumed that m = 6, s =3, e = 0.2, $\alpha = 2$, $r^* = 1.0$, $\delta = \delta^* = 0.3$, and $x_2 + x_3 = x_2^* + x_3^*$ = 0.05. Since deltas and *x's* are given externally in the trade agreement, they are assumed to be constant. And r is assumed to change over this period for an unknown factor: r = 1.2 (for t = 1 –149), 0.8 (for t = 150 –299), 1.1 (for t = 300 – 400).

(i) t = 1 – 149

During this period, r is 1.2 and the import-competing sector in the domestic country has much political power. The payoff of G (a one-shot game) becomes

		Foreign Country			
		F		P	
Domestic Country	F	3.10	3.00	3.05	2.97
	P	3.09	2.93	3.09	2.96

First, it is noted that there are two Nash equilibria (F, F) and (P, P): I selected the values of the parameters intentionally to achieve that. Criterion of risk dominance (9) becomes

0.00035 < 0.001225.

Hence, (P, P) is risk dominant. This reflects the much political power of the domestic import-competing industry. Threshold values for the countries to select actions are

$\beta = 0.79$ and $\beta^* = 0.49$ (from (6) and (7)).

The result of the simulation is shown in figure 1. I assumed that the state at t = 0 is

PFPFPF
FPFPFP.

I created randomness using a random number table and tumbling dice. "Degree of Liberalization (DoL)" is defined as the proportion of F in a state (see the notes of figure 1). If we look at t = 1 – 149 in figure 1, we can find that DoL is close to 0 during this period. Strictly speaking, DoL = 0 does not necessarily happen at the most frequency due to a comparatively large error rate e = 0.2. And around t = 70, DoL is more than 0.3 and a little bit close to free trade regime because the governments made errors rather frequently. On the whole, however, we can observe the states close to the protectionist regime during this period.

(ii) t = 150 – 299

During this period, r = 0.8: the domestic import-competing sector lost its influence on the government for unknown reasons. Then the payoff matrix becomes

		Foreign Country			
		F		P	
Domestic Country	F	2.90	3.00	2.84	2.97
	P	2.86	2.95	2.86	2.98

The criterion of risk dominance is

$0.001134 > 0.000544$.

Thus, (F, F) is risk dominant. The threshold values are

$\boldsymbol{b} = 0.30$ and $\boldsymbol{b}^* = 0.53$.

See t = 150 – 299 in figure 1. First, it is noteworthy that the free trade regime (DoL = 1) was not achieved right after t = 150. Since the state at t = 149 was

PFPPPP
PPPPPP,

the free trade regime (DoL = 1) would have been reached in 6 periods at minimum.

Actually the DoL reached 1 at t = 175 for the first time: it took 25 periods. If we take a closer look, we find that the states even reverted to the protectionist regime right after t = 150. This reflects the fact that a bad memory from the past protectionism lingered on and the fact that a few errors occurred. Once the DoL starts to rise, however, it gains a momentum and reaches 1 in short periods. This is because once F begins to increase in a state, then the probability for both governments to choose F increases, and this raises the ratio of F in a state: a good cycle emerges[14]. And after t = 175, the states close to the free trade regime (DoL = 1) is likely to be observed.

(iii) t = 300 – 400

I considered this case to arouse a caution. During this period, r = 1.1 and the import-competing sector regained a part of the political influence which it used to have. The payoff matrix is

[14] If r increases contrary to the above case, then the opposite phenomenon will occur. This reminds me of the episodes before WWII.

		Foreign Country			
		F		P	
Domestic Country	F	3.05	3.00	3.00	2.97
	P	3.03	2.94	3.03	2.97

The threshold values are

$\boldsymbol{b} = 0.63$ and $\boldsymbol{b}^* = 0.49$.

The criterion of risk dominance 0.000629 < 0.001029 implies that (P, P) is risk dominant. But as we can see from t = 300 – 400 in figure 1, neither the free trade regime (DoL = 1.0) nor the protectionist regime (DoL = 0.0) is stochastically stable. Although the free trade regime seems to be stochastically stable until around t = 330, it is just because the past history lingers on. Thus, contrary to the Young's theorem, risk dominance does not correspond one to one with stochastic stability. This difference comes from the fact that in this simulation *s* is small (=3). If *s* is small like this, a rather large change in a parameter value (like r = 1.2 → 0.8) is required for the stochastically stable state to switch from a convention to the other[15]. However, the tendency of the proposition still holds.

Concluding Remarks and Extensions

I analyzed the long run consequences of "free trade versus protection" game with adaptive learning. I assumed that governments are less rational and have less information than usually assumed in a traditional model, and used a concept of Young's (1998) "stochastically stable states". A major result is that if political influences of import-competing industries are small, or if punishment to violating obligation of the trade agreement is large enough, then the free trade regime is likely to be observed over the long run in most cases.

Even the author does not believe that actual governments behave purely in the manner of adaptive learning. Based on these simplifying assumptions, however, we can derive several interesting results that may be observed in actual trade negotiations: First, even if the foreign government's r^* (weight of import-competing sectors) is unchanged, if domestic government's r gets smaller, then the foreign government is also likely to choose free trade, because its behavior is affected by the history of the domestic government's actions. Second, even if both governments prefer free trade due to small r or r^*, it might take a long time to achieve free trade regime when past bad memories linger on (remember case (ii) of the simulation). Third, if the domestic government is an extreme free trade supporter, the foreign rival is an extreme protectionist, and the domestic government supports free trade further, then the threat of punishment from domestic to foreign becomes smaller enough and the protectionist regime might prevail.

To derive the above results, I assumed that the methods of drawing a sample (memory m, or sample size s) are common for the two countries, memories are bounded, and r or r^* is externally given. A possible extension should be considering the case in which the methods of sampling (for instance, m or s) differ in each country or memories are unbounded. Another possible extension is assuming that r is determined endogenously. As is in Grossman and Helpman (1993), r might be interpreted as a reflection of lobbying contributions by the import-competing sector. If "protection (positive tariffs)" is chosen by the government, then the import-competing sector might increase its contributions to the government. And this history might induce the government to raise r. If this is the case, once trapped in protectionism, the government will not try to escape from it. By contrast, as we learned from the episodes before WWII, if the free trade regime lasts long, dissatisfaction of import-competing sector tends to be accumulated and r might be increased. The extended analysis in this direction is anticipated.

In addition, I assumed binary choices in this paper for simplicity: the governments select Free trade (a zero tariff) or Protection (a Nash tariff). This assumption is not immune from the criticism that it is too ad hoc. Thus, I will extend my model to a more general setup with more than two levels of protection.

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[15] if s is 3, the proportion of F is one of the four numbers: 0, 0.33…, 0.66…, 1. It matters where the threshold values come compared with these numbers. Only if the relative sizes of the threshold values to

References

Bac, M. and H. Raff (1994), "A theory of trade concessions", mimeo, Indiana University

Bagwell, K. and R.W. Staiger (1990), "A theory of managed trade", American Economic Review 80, pp.779-795

Bagwell, K. and R.W. Staiger (1993a), "Multilateral tariff cooperation during the formation of free trade areas", National Bureau of Economics Research Working Paper No. 4364.

Bagwell, K. and R.W. Staiger (1993b), "Multilateral tariff cooperation during the formation of customs unions", National Bureau of Economics Research Working Paper No. 4543.

Economist (Jan. 8th-14th, 2000)

Friedman, J.W., and C. Mezzetti (1999) "Learning in games by random sampling", University of North Carolina at Chapel Hill, Department of Economics Working Paper 99-04

Grossman, G.M. and E. Helpman (1993), "Trade wars and trade talks", National Bureau of Economics Research Working Paper No. 4280

Hungerford, T.L. (1991), "GATT: A cooperative equilibrium in a non cooperative trading regime?", Journal of International Economics 31, pp.357-369

O'Rourke, K. and J. Willamson (1999), "Globalization and History: The Evolution of a Nineteenth-Century Atlantic Economy", Cambridge, MIT

Staiger, R.W. (1995), "International Rules and Institutions for Trade Policy" in Handbook of International Economics, vol.3, edited by Grossman, G. and K. Rogoff. Amsterdam: North-Holland

Young, P. (1998), "Individual Strategy and Social Structure: An Evolutionary Theory of Institutions", New Jersey, Princeton University Press

these numbers are altered, the stochastically stable outcome changes.

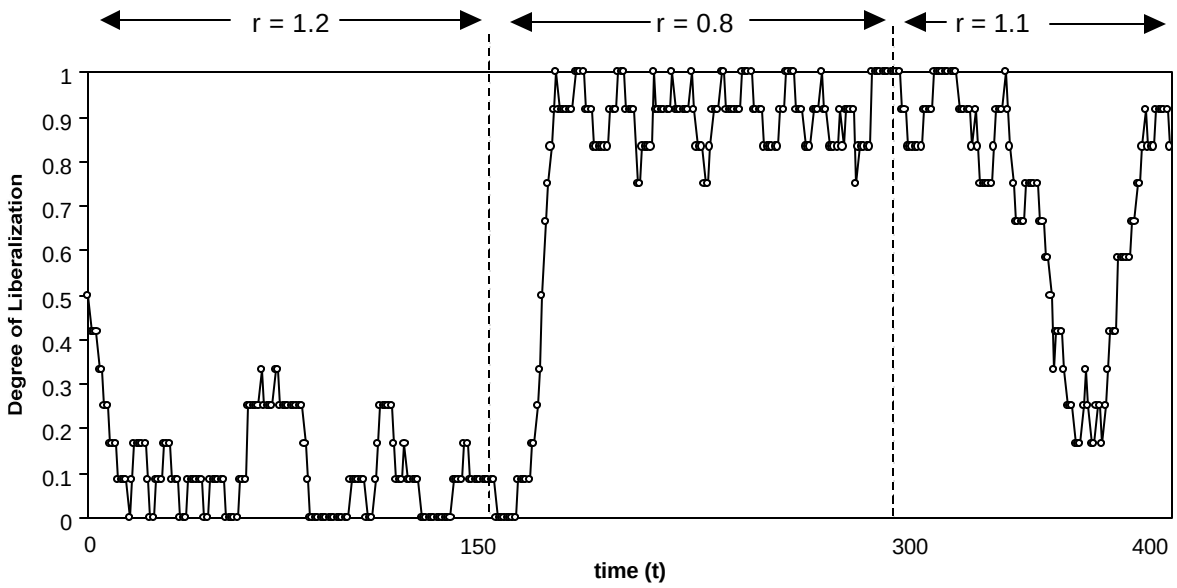
Table 1 Process of the Trade Talks

At t = 1,

- With probability 1-e, the domestic country observes r and r^*, and calculates β using (6). Then it draws a sample of size s from the set of actions taken by the foreign government over the last m periods and calculates the proportion of F in the sample. If this proportion is larger (smaller) than β, then it selects F (P) and sets the tariff level to zero (r/3).
- With probability e, the domestic country makes an error and chooses F or P at random. If it selects F (P), then it sets the tariff to zero (r/3).
- The foreign country behaves simultaneously in a similar manner. Its memory m, sample size s, and error rate e are the same. Errors occur and samples are drawn independently of the domestic behavior.
- Consumption and trade take place.
- If a country chooses F and the other chooses P, then external punishments are levied on the country which selected P. Otherwise, nothing is levied.

- The above process is repeated for t = 1, 2, 3…

Figure 1 Results of Simulation



(Notes) Degree of Liberalization represents the proportion of F (free trade) in a state.
For example, if the state is
PPFPFP
PFPPPP
then the degree of liberalization is 3/12 = 0.25.
Note that this is a concept with the two countries taken together.
The initial state at t = 0 is assumed to be
PFPFPF
FPFPFP.