



Trade Agreements

The Purpose of
Trade
Agreements

A Tariff Setting
Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated
Game and the
Design of Trade
Agreements

Flexible Trade
Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

Strategies and Games

CHAPTER 20

Trade Agreements



Trade Agreements

Roadmap

Trade Agreements

The Purpose of
Trade
Agreements

A Tariff Setting
Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated
Game and the
Design of Trade
Agreements

Flexible Trade
Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

1 The Purpose of Trade Agreements

2 A Tariff Setting Game

■ FREE TRADE

■ TARIFFS

■ GOVERNMENT WELFARE AND THE NASH EQUILIBRIUM

■ THE PRISONER'S DILEMMA

3 The Repeated Game and the Design of Trade Agreements

4 Flexible Trade Agreements

■ FREE TRADE AGREEMENT WITH NO FLEXIBILITY

■ FREE TRADE AGREEMENT WITH AN ESCAPE CLAUSE

5 Summary



Trade Agreements

Roadmap

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

1 The Purpose of Trade Agreements

2 A Tariff Setting Game

3 The Repeated Game and the Design of Trade Agreements

4 Flexible Trade Agreements

5 Summary



Terms of Trade

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE

AND THE NASH

EQUILIBRIUM

THE PRISONER'S

DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT

WITH NO FLEXIBILITY

FREE TRADE AGREEMENT

WITH AN ESCAPE

CLAUSE

Summary

- Suppose that the EU imposes a 10% import tariff on US cars.
- If the EU demand for US cars is sizeable, then lower EU and hence global demand for US cars will push down their price.
- EU terms of trade improve: they can now import 'more' US cars for every unit of aluminum they export to the US.
- EU is benefiting *at the expense of* the US. This '*me first*' incentive = *Beggar Thy Neighbor* trade policy (Joan Robinson, 1937.)
- Countries have a *dominant strategy to impose a tariff unilaterally*, and along the road hurt their trading partner.



Tariffs and the Terms of Trade

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

- US can react by imposing import tariff of 10% on EU aluminum.
- Even if both tariffs cancel out each other's effect on the terms of trade, their presence is not neutral.
- The tariffs *reduce economic activity in both countries* making both worse off compared to the no-tariff scenario.
- This is 'Terms-of-trade' **prisoner's dilemma**.
- **Design of a trade agreement** to give incentives to countries to escape this prisoner's dilemma in a voluntary fashion.
 - In game theory parlance, a trade agreement must be self-enforcing: an SPE of a repeated tariff setting game.



Trade Agreements

Roadmap

Trade Agreements

The Purpose of
Trade
Agreements

A Tariff Setting
Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated
Game and the
Design of Trade
Agreements

Flexible Trade
Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

1 The Purpose of Trade Agreements

2 A Tariff Setting Game

- FREE TRADE

- TARIFFS

- GOVERNMENT WELFARE AND THE NASH EQUILIBRIUM

- THE PRISONER'S DILEMMA

3 The Repeated Game and the Design of Trade Agreements

4 Flexible Trade Agreements

5 Summary



A Tariff Setting Game

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

A Basic model based on Bagwell and Staiger (1990)

- America ('A') and Europe ('E') trade in two goods, a and b .
- America (Europe) is an exporter of good a (b) and an importer of good b (a).
- The market for good a .
 - The demand for good a in America is $D_A^a(P_a) = 2 - P_a$, where P_a is the price of good a .
 - The demand for good a in Europe is $D_E^a(P_a) = 2 - P_a$.
 - Fixed supply America of $a = S_A^a = 1 + \theta$. Fixed supply Europe of $a = S_E^a = 1 - \theta$.
 - Total world supply, $S_A^a + S_E^a$, of good a is thus fixed at 2.



A Tariff Setting Game

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE

AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

- The market for good b is almost identical to that of a :
 - America's demand for good b is $D_A^b(P_b) = 2 - P_b$.
 - Europe's demand for good b is $D_E^b(P_b) = 2 - P_b$.
 - Fixed supply America of $b = S_A^b = 1 - \theta$. Fixed supply Europe of $b = S_E^b = 1 + \theta$.
 - The total world supply of good b is thus also fixed at two.
- For simplicity we assume that firms incur *no costs*.



A Tariff Setting Game

Free Trade

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE AND THE NASH EQUILIBRIUM

THE PRISONER'S DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT WITH NO FLEXIBILITY

FREE TRADE AGREEMENT WITH AN ESCAPE CLAUSE

Summary

- Free trade: “world supply” balances “world demand” at $P_a = P_b = 1$.
- Imports of a and b are both equal to θ .



A Tariff Setting Game

Equilibrium with Tariffs

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

To understand how this reasoning plays out in the model we need to determine two things:

- 1 How does a tariff affect the *market equilibrium*?
- 2 How does a tariff affect a *country's (government) payoff*?



A Tariff Setting Game

Equilibrium with Tariffs

Trade Agreements

The Purpose of
Trade
Agreements

A Tariff Setting
Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated
Game and the
Design of Trade
Agreements

Flexible Trade
Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

Impact of a per unit tariff

- Tariff t_A will, in the *same way as a tax*, drive a wedge between import and export price:

$$p_A^b = p_E^b + t_A$$

- At the market equilibrium for good b :

$$D_A^b(t_A) - S_A^b(t_A) = S_E^b(t_A) - D_E^b(t_A) \Leftrightarrow M^b(t_A) = X^b(t_A)$$

- This happens when:

$$p_A^b = 1 + \frac{t_A}{2} \text{ and } p_E^b = 1 - \frac{t_A}{2}.$$

- **Terms of trade effect:** the tariff lowers the price of good b in Europe and increases its price in America.



A Tariff Setting Game

Equilibrium with Tariffs

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

- As long as $t_A < 2\theta$ there will be trade.

$$M^b(t_A) = X^b(t_A) = \theta - \frac{t_A}{2}.$$

- What about Europe's tariff t_E ? Market equilibrium for good a occurs when:

$$P_A^a = 1 - \frac{t_E}{2}; \text{ and } P_E^a = 1 + \frac{t_E}{2}.$$



A Tariff Setting Game

Government Welfare And The Nash Equilibrium

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

Assume that both countries care (equally) about:

- 1 The benefits domestic consumers obtain from market participation: *consumer surplus*
- 2 The benefits domestic firms obtain from market participation: *producer surplus*
- 3 The *tariff revenue* collected.



A Tariff Setting Game

Government Welfare And The Nash Equilibrium

Trade Agreements

The Purpose of
Trade
Agreements

A Tariff Setting
Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated
Game and the
Design of Trade
Agreements

Flexible Trade
Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

1 Consumer surplus, $CS_A^b(t_A) = \frac{1}{2}(1 - \frac{t_A}{2})^2$.

- Consumer surplus decreases with the tariff.

2 Producer surplus, $PS_A^b(p_A^b) = (1 + \frac{t_A}{2})(1 - \theta)$.

- Producer surplus increases with the tariff.

3 Tariff revenue, $R_A^b(p_A^b) = t_A(\theta - \frac{t_A}{2})$.

- Tariff revenue first increases and then decreases with tariff t_A . (Why?).



A Tariff Setting Game

Government Welfare And The Nash Equilibrium

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE AND THE NASH EQUILIBRIUM

THE PRISONER'S DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT WITH NO FLEXIBILITY

FREE TRADE AGREEMENT WITH AN ESCAPE CLAUSE

Summary

The Objective Function

- Welfare in America's 'IMPORT MARKET:

$$W_A^b(t_A) = CS_A^b(t_A) + PS_A^b(t_A) + R_A^b(t_A) = \frac{3}{2} - \theta + \frac{t_A \theta}{2} - \frac{3t_A^2}{8}$$

- Welfare in In America's EXPORT MARKET:

$$W_A^a(t_E) = \frac{3}{2} + \theta - \frac{t_E \theta}{2} + \frac{t_E^2}{8}.$$

- Total American welfare given tariffs t_A and t_E is

$$W_A(t_A, t_E) = W_A^a(t_E) + W_A^b(t_A) = 3 + \frac{t_A \theta}{2} - \frac{3t_A^2}{8} - \frac{t_E \theta}{2} + \frac{t_E^2}{8}$$

- Total European welfare:

$$W_E(t_A, t_E) = W_E^a(t_E) + W_E^b(t_A) = 3 + \frac{t_E \theta}{2} - \frac{3t_E^2}{8} - \frac{t_A \theta}{2} + \frac{t_A^2}{8}$$



A Tariff Setting Game

Government Welfare And The Nash Equilibrium

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE AND THE NASH EQUILIBRIUM

THE PRISONER'S DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT WITH NO FLEXIBILITY

FREE TRADE AGREEMENT WITH AN ESCAPE CLAUSE

Summary

The Nash Equilibrium

- it is a **dominant strategy** for each country to set its tariff equal to $\frac{2\theta}{3}$.
- Nash equilibrium =

$$(t_A^*, t_E^*) = \left(\frac{2\theta}{3}, \frac{2\theta}{3}\right).$$

- Nash Equilibrium payoffs for each country are equal to

$$3 - \frac{\theta^2}{9}.$$



A Tariff Setting Game

The Prisoner's Dilemma

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE AND THE NASH EQUILIBRIUM

THE PRISONER'S DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT WITH NO FLEXIBILITY

FREE TRADE AGREEMENT WITH AN ESCAPE CLAUSE

Summary

- The key feature of the prisoner's dilemma:
 - The prisoners jointly would like to cooperate but they each have a dominant strategy to deviate!
- The tariff game shares these exact features:
 - The countries would rather coordinate on *low* tariffs but in a one-shot tariff game with terms of trade considerations they set *high* import tariffs.
- To see this, consider the expression for *global welfare*

$$W(t_A, t_E) = W_A(t_A, t_E) + W_E(t_A, t_E) = 6 - \frac{t_A^2}{4} - \frac{t_E^2}{4}.$$

- Global welfare, and hence each country's welfare, goes up when tariffs are *mutually* lowered.



Trade Agreements

Roadmap

Trade Agreements

The Purpose of
Trade
Agreements

A Tariff Setting
Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated
Game and the
Design of Trade
Agreements

Flexible Trade
Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

1 The Purpose of Trade Agreements

2 A Tariff Setting Game

3 The Repeated Game and the Design of Trade Agreements

4 Flexible Trade Agreements

5 Summary



The Repeated Game and the Design of Trade Agreements

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

How to escape the terms of trade prisoner's dilemma?

- GOAL: Jointly reducing the tariffs to some *cooperative level* t_C , where $t_C < t_{Nash} = \frac{2\theta}{3}$,
- IDEA: If the game is repeated infinitely, then t_C could become a self enforcing equilibrium outcome, as long as decision makers are patient enough.
- A *trade agreement is designed* to make such mutual tariff concession *explicit*.
 - The trade agreement will be self-enforcing as long as no deviation will occur in any subgame of the repeated tariff game.



The Repeated Game and the Design of Trade Agreements

Trade Agreements

The Purpose of
Trade
Agreements

A Tariff Setting
Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated
Game and the
Design of Trade
Agreements

Flexible Trade
Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

- Under which condition do grim trigger strategies support cooperation in an infinitely repeated tariff game?
- Will establish two results:
 - 1 Cooperation is easier to obtain when imports are small.
 - 2 Cooperation is harder to obtain for lower levels of cooperative tariff t_C .



The Repeated Game and the Design of Trade Agreements

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

- Discounted payoff of cooperative tariff t_C :

$$\frac{1}{1-\delta} \left[3 - \frac{t_C^2}{4} \right].$$

- Best deviation: set $t_N = \frac{2\theta}{3}$ and anticipate Nash reversion with discounted payoff:

$$3 + \frac{\theta^2}{6} - \frac{t_C\theta}{2} + \frac{t_C^2}{8} + \frac{\delta}{1-\delta} \left[3 - \frac{\theta^2}{9} \right].$$

- Critical discount factor, δ^* :

$$\delta^* = \frac{12\theta^2 - 36t_C\theta + 27t_C^2}{20\theta^2 - 36t_C\theta + 9t_C^2}.$$

- Note that *free trade* — $t_C = 0$ — can be sustained as long as $\delta > \delta^* = \frac{3}{5}$.



The Repeated Game and the Design of Trade Agreements

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE AND THE NASH EQUILIBRIUM

THE PRISONER'S DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT WITH NO FLEXIBILITY

FREE TRADE AGREEMENT WITH AN ESCAPE CLAUSE

Summary

The following table lists the critical discount factor for different values of import levels (θ) and cooperative tariffs (t_C).

θ	t_C	δ^*	θ	t_C	δ^*
0.1	0.025	0.405	0.25	0.05	0.447
0.2	0.025	0.506	0.25	0.025	0.526
0.4	0.025	0.554	0.25	0	0.6

Table 20.1



The Repeated Game and the Design of Trade Agreements

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

Two lessons emerge from studying the critical discount factor δ^*

Lesson 1. The more ambitious the trade agreement — the lower t_C — the more patience is needed for it to be self enforcing.

Lesson 2. Higher levels of imports — higher θ — increase the incentives to deviate.



Trade Agreements

Roadmap

Trade Agreements

The Purpose of
Trade
Agreements

A Tariff Setting
Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated
Game and the
Design of Trade
Agreements

Flexible Trade
Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

1 The Purpose of Trade Agreements

2 A Tariff Setting Game

3 The Repeated Game and the Design of Trade Agreements

4 Flexible Trade Agreements

- FREE TRADE AGREEMENT WITH NO FLEXIBILITY
- FREE TRADE AGREEMENT WITH AN ESCAPE CLAUSE

5 Summary



Flexible Trade Agreements

Trade Agreements

The Purpose of
Trade
Agreements

A Tariff Setting
Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated
Game and the
Design of Trade
Agreements

Flexible Trade
Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

- An important institutional feature of the WTO agreement is that it leaves room for *tariff flexibility*.
 - *Safeguards* are a good example of WTO sanctioned trade instruments permitting such flexibility:
- *Flexibility may enhance the appeal* of a trade agreement.
 - If the low tariffs of a trade agreement are committed to, i.e. non-flexible, countries may be hesitant to 'join the club'.



Flexible Trade Agreements

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

- *Flexibility* may *facilitate* the signing of a trade agreement.
- How so?
- Let us introduce *uncertainty* about the amount of *imports* that America and Europe face. In each period
 - there is a 50% chance that imports are 'high' in both countries — equal to $\theta + \varepsilon$ —
 - a 50% chance that imports are 'low' — equal to $\theta - \varepsilon$.



Flexible Trade Agreements

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

What is the expected welfare of playing Nash tariffs, W_N^e

- $\tau_N^A(\theta + \varepsilon) = \tau_N^E(\theta + \varepsilon) = \frac{2(\theta + \varepsilon)}{3}$ when they face high imports and $\tau_N^A(\theta - \varepsilon) = \tau_N^E(\theta - \varepsilon) = \frac{2(\theta - \varepsilon)}{3}$ when they face low imports.

- This yields expected welfare W_N^e

$$W_N^e = \frac{1}{2} W_N(\theta + \varepsilon, \theta + \varepsilon) + \frac{1}{2} W_N(\theta - \varepsilon, \theta - \varepsilon) = W_N^e = 3 - \frac{\theta^2 + \varepsilon^2}{9}.$$



Flexible Trade Agreements

No Flexibility

Trade Agreements

The Purpose of
Trade
Agreements

A Tariff Setting
Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated
Game and the
Design of Trade
Agreements

Flexible Trade
Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

- Fully free trade agreement: no tariffs, *no exceptions allowed*.
- Discounted welfare from adhering to the agreement, w_0 , does not depend on the level of imports:

$$w_0 = \frac{3}{1 - \delta}.$$

- The payoff from deviating *does* depend on the level of imports.
 - In particular, the higher the level of imports, the higher the benefit from unilaterally deviating to the Nash tariff.
 - The stage game payoff from deviation when the import level is $\theta + \varepsilon$ is then

$$W^{Dev}(t_N, 0) = 3 + \frac{(\theta + \varepsilon)^2}{6}.$$



Flexible Trade Agreements

Trade Agreements

The Purpose of
Trade
Agreements

A Tariff Setting
Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated
Game and the
Design of Trade
Agreements

Flexible Trade
Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

- Expected discounted payoff from deviation, w_0^{Dev} , is:

$$w_0^{Dev} = W^{Dev}(t_N, 0) + \frac{\delta}{1-\delta} W_N^e = 3 + \frac{(\theta + \varepsilon)^2}{6} + \frac{\delta}{1-\delta} \left(3 - \frac{\theta^2 + \varepsilon^2}{9} \right).$$

- The critical discount factor, δ^{Rigid} , ensuring compliance is

$$\delta^{Rigid} = \frac{3(\theta^2 + \varepsilon^2) + 6\theta\varepsilon}{5(\theta^2 + \varepsilon^2) + 6\theta\varepsilon}.$$

- The critical discount factor δ^{Rigid} increases with ε .
 - The higher the level of import fluctuations, the harder it becomes to sign a free trade agreement.*



Flexible Trade Agreements

Flexibility

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

- Suppose now that the design of the trade agreement allows for an **escape clause**:
 - When both countries are 'hit' by an import 'surge' — $\theta + \varepsilon$ — they are allowed to, for one period, set an import tariff equal to $t > 0$.
 - This institutional feature makes it easier for the countries to agree on a trade agreement ex ante.



Flexible Trade Agreements

Flexibility

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE AND THE NASH EQUILIBRIUM

THE PRISONER'S DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT WITH NO FLEXIBILITY

FREE TRADE AGREEMENT WITH AN ESCAPE CLAUSE

Summary

- Countries will comply with the flexible trade agreement as long as the expected discounted welfare from compliance is larger than the expected discounted welfare from a deviation.
- With an escape clause and in the case of an export surge the payoff from cooperation is illustrated in Table 20.2:

A \ E	$t_E = 0$		$t_E = t$	
	$t_A = 0$	$t_A = t$	$t_A = 0$	$t_A = t$
	3, 3	$3 + \frac{t(\theta+\varepsilon)}{2} - \frac{3t^2}{8}$	$3 - \frac{t(\theta+\varepsilon)}{2} + \frac{t^2}{8}$	$3 + \frac{t(\theta+\varepsilon)}{2} - \frac{3t^2}{8}$
	$3 - \frac{t(\theta+\varepsilon)}{2} + \frac{t^2}{8}$	$3 - \frac{t(\theta+\varepsilon)}{2} + \frac{t^2}{8}$	$3 - \frac{t^2}{4}$	$3 - \frac{t^2}{4}$

Table 20.2



Flexible Trade Agreements

Flexibility

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

- These scenarios have equal likelihood, allowing us to write the per-period expected welfare as

$$W_C^e(t) = 3 - \frac{t^2}{8}.$$

- Cooperating thus yields the discounted payoff stream, w_C :

$$w_C = \frac{1}{1 - \delta} \left(3 - \frac{t^2}{8} \right).$$



Flexible Trade Agreements

Flexibility

Trade Agreements

The Purpose of
Trade
Agreements

A Tariff Setting
Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated
Game and the
Design of Trade
Agreements

Flexible Trade
Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

- A deviation will be deterred when

$$3 - \frac{t^2}{4} + \frac{\delta}{1 - \delta} \left(3 - \frac{t^2}{8} \right) > 3 + \frac{(\theta + \varepsilon)^2}{6} - \frac{t(\theta + \varepsilon)}{2} + \frac{t^2}{8} + \frac{\delta}{1 - \delta} \left(3 - \frac{\theta^2 + \varepsilon^2}{9} \right)$$

- The critical discount factor — δ^{Flex} — is equal to

$$\delta^{Flex} = \frac{27t^2 + 12(\theta + \varepsilon)^2 - 36t(\theta + \varepsilon)}{18t^2 + 12(\theta + \varepsilon)^2 + 8(\theta^2 + \varepsilon^2) - 36t(\theta + \varepsilon)}.$$

- If $t = 0$, we are back in the no flexibility scenario and it logically follows that $\delta^{Flex} = \delta^{Rigid}$.
- If there is no uncertainty, $\varepsilon = 0$, then δ^{Flex} coincides with the critical discount factor δ^*



Flexible Trade Agreements

Flexibility

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE

AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

- One interesting **benchmark case** deserves attention.
- Presume that both America and Europe have a discount factor equal to $\frac{3}{5}$;
 - They are just willing to sign a free trade agreement if there is no uncertainty at all.
 - Any level of import uncertainty, $\varepsilon > 0$, implies that they will not sign a free trade agreement.



Flexible Trade Agreements

Flexibility

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

- Lowest level of the escape clause call it $\underline{t}(\theta, \varepsilon)$, so that they want to sign a free trade agreement?
- This escape clause tariff satisfies $\delta^{Flex} = \frac{3}{5}$ if $t = \underline{t}(\theta, \varepsilon)$.

$$\underline{t}(\theta, \varepsilon) = \frac{4}{9}\theta + \varepsilon - \sqrt{\theta^2 + \varepsilon^2 - \theta\varepsilon}.$$



Flexible Trade Agreements

Flexibility

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

- Let $\theta = \frac{1}{4}$ and $\varepsilon = \frac{1}{16}$. Then

$$\underline{t}(\theta, \varepsilon) = \frac{4}{9} \left[\frac{1}{4} + \frac{1}{16} - \sqrt{\frac{1}{16} + \frac{1}{256} - \frac{1}{64}} \right] = 0.039.$$

- The Nash tariff is $t_N = \frac{2}{3} \left[\frac{1}{4} + \frac{1}{16} \right] = 0.208$,
- The escape clause tariff needed to sustain cooperation is less than 20% of the Nash tariff.
- The welfare loss, compared to free trade, due to the introduction of the the escape clause is only just 2.6% of the welfare loss that is caused by Nash tariffs.
- We conclude that the *flexibility offered by an escape clause can be instrumental to guarantee that a trade agreement is self-enforcing, at a relatively low cost in welfare.*



Trade Agreements

Roadmap

Trade Agreements

The Purpose of
Trade
Agreements

A Tariff Setting
Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE
AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated
Game and the
Design of Trade
Agreements

Flexible Trade
Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

- 1 The Purpose of Trade Agreements
- 2 A Tariff Setting Game
- 3 The Repeated Game and the Design of Trade Agreements
- 4 Flexible Trade Agreements
- 5 Summary



SUMMARY

Trade Agreements

The Purpose of Trade Agreements

A Tariff Setting Game

FREE TRADE

TARIFFS

GOVERNMENT WELFARE

AND THE NASH
EQUILIBRIUM

THE PRISONER'S
DILEMMA

The Repeated Game and the Design of Trade Agreements

Flexible Trade Agreements

FREE TRADE AGREEMENT
WITH NO FLEXIBILITY

FREE TRADE AGREEMENT
WITH AN ESCAPE
CLAUSE

Summary

- 1 When using trade instruments unilaterally (e.g import tariffs) countries become entangled in a terms of trade driven prisoner's dilemma.
- 2 The rules of trade agreements are often designed to facilitate the reciprocal reduction in tariffs. In an infinitely repeated tariff game, such joint reduction can be sustained in a SPE using grim trigger strategies.
- 3 The higher the level of imports and the higher the tariff reductions, the harder it becomes for countries to agree to signing a trade agreement.
- 4 Uncertainty jeopardizes cooperation even further as countries have a stronger incentive to break the rules when import volumes are high.
- 5 Flexibility, such as safeguards, in times of high import volumes can mitigate this problem, increasing the appeal of the trade agreement.