Trade Policy and Industrial Policy for a Two-Country-Two-Good-Two-Factor Economy

(Extension of "Optimum Tariff and Retaliation")

Project for ECON567 Computer Modeling for Economic Policy Analysis

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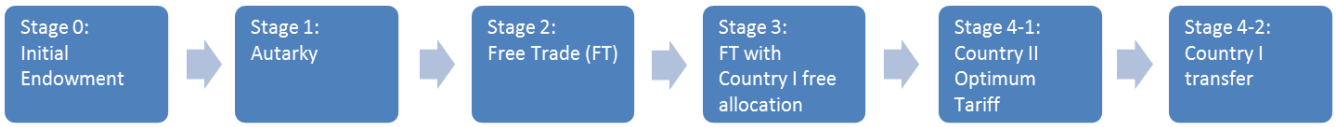
I. Introduction

This case is an extension of our first project that simulates tariff retaliation between two countries, which is based on Harry Johnson's work on optimum tariff. As Harry Johnson's another paper indicates, optimum tariff sometimes may not be the best solution for a country to maximize its utility. Besides imposing optimum tariff, there are other alternatives for a country to take in order to maximize its utility, such as optimum quota and direct transfer from one country to another country.

Theoretically, optimum quota and optimum tariff are equivalent approaches, but transfer approach could create higher utility level for the trade participant's compared to the utility level under optimum tariff. Our case is to simulate results under transfer scenario and optimum tariff, based on which we could make comparison and further discussion.

In this case, the trade scenario between a developing country I and a developed country II is offered. According to figure 1, our simulation starts with initial endowment and then utility optimization of autarky scenario at stage 1. Stage 2 is a free trade state, where countries are allowed to exchange freely for optimization. At stage 3, country I could design an industrial policy to reallocate its factors of production to maximize its utility, taking into account country II 's fixed structure of production. Stage 4.1 is country II impose optimum tariff in response to country I's industrial policy. In comparison, state 4.2 is country make direct transfer to country II in order to avoid tariff imposed by its trade partner. As for the stage of country I designing industrial policy to maximize its utility, a real-life example could be the trade between United States and China. China, being the developing country I, conducting policy as to produce more labor-intensive products in exchange for American capital-intensive products.

Figure 1 Simulation process of this case



II. Model

A. Assumptions

1) Economy structure

- Two countries: country I (developing country) and country II(developed country).
- Two goods: good A and good B. Inferior goods are ruled out in this economy.
- Individuals in the population of each country have the same preference between good A and good B, i.e. the same utility function. Thus, the population in one country can behave collectively as a single entity.
- Initial endowment: Country I, 20000 labors and 20000 capital; Country II, 20000 labor and 20000 capital.
- Country I has better technology in producing A with labor, but better technology in producing B with capital

$$IA = IAL^{0.4} \times IAK^{0.1} \quad IB = IBL^{0.1} \times IBK^{0.4}$$

- Country II has better technology in producing A with capital, but better technology in producing B with labor

$$IIA = IIAL^{0.1} \times IIAK^{0.4} \quad IB = IIBL^{0.4} \times IBK^{0.1}$$

- Cobb-Douglas utility functions:

$$UI = 2 \times (IA - Ae)^{0.3} \times (IB + Be)^{0.7}$$

$$UII = 2 \times (IIA + Ae)^{0.7} \times (IIB - Be)^{0.3}$$

- Both countries aim to maximize it utility.
- There is no transaction cost in international trade.

2) Price

In this two-country, two-good economy, no currency is needed and good A is only exchanged for good B. Therefore, we use relative price in this barter economy and define relative price P as the quantity of A to be traded for one unit of B.

$$P = Ae / Be = PB / PA$$

3) Restrictions

- **Trade balance**

It is assumed that the countries in this economy seek a balance of trade, where total value of imports is equivalent to total value of exports. This restriction will be relaxed in stage 4.2 when transfer happens.

$$P \times Be = Ae$$

- **Material balance**

Within each country, labor and capital can be distributed into industry A and B.

IAL+IBL=20000, IIAL+IIBL=20000; IAK+IBK=20000, IAK+IBK=20000;

- **Consumption ratio**

At each equilibrium point, the marginal rate of substitution in each country equals to the inverse of relative price in that country. And these generate the following consumption ratio equations:

$$\text{Country I}: (\text{IA} - \text{Ae}) \times 7 = (\text{IB} + \text{Be}) \times \text{PI} \times 3$$

$$\text{Country II}: (\text{IIB} - \text{Be}) \times 7 \times \text{PII} = (\text{IIA} + \text{Ae}) \times 3$$

B. Variables

In this model, there are 19 variables in total. 8 variables are about factor of production in two countries, and 4 variables are about the production in both countries. P,PI and PII are endogenous variables about relative price. The remaining two variables Ae and Be are the exchange amount of A and B respectively.

Table 1 Variables definitions

	Variable	Type	Definition	Initial value
1	***IA***	Endogenous/Exogenous	Production of A in Country I	100
2	***IB***	Endogenous/Exogenous	Production of B in Country I	100
3	***IIA***	Endogenous/Exogenous	Production of A in Country II	100
4	***IIB***	Endogenous/Exogenous	Production of B in Country II	100
5	***Ae***	Endogenous	Trade of A between I and II	0
6	***Be***	Endogenous	Trade of B between I and II	0
7	***P***	Endogenous	World relative price	1
8	***PI***	Endogenous	Relative price in country I	1
9	***PII***	Endogenous	Relative price in country II	1
10	***IAL***	Endogenous/Exogenous	Country I labor in A	10000
11	***IBL***	Endogenous/Exogenous	Country I labor in B	10000
12	***IAK***	Endogenous/Exogenous	Country I capital in A	10000
13	***IBK***	Endogenous/Exogenous	Country I capital in B	10000
14	***IIAL***	Endogenous/Exogenous	Country II labor in A	10000
15	***IIBL***	Endogenous/Exogenous	Country II labor in B	10000
16	***IIAK***	Endogenous/Exogenous	Country II capital in A	10000
17	***IIBK***	Endogenous/Exogenous	Country II capital in B	10000
18	***Tariff_1***	Exogenous	Tariff country I impose on imports of B	0
19	***Tariff_2***	Endogenous/Exogenous	Tariff country II impose on imports of A	0
20	***Transfer A***	Endogenous	Transfer of A from country I to country II	0
21	***Transfer B***	Endogenous	Transfer of B from country II to country I	0
22	***UI***	Endogenous	Utility for Country I	200
23	***UII***	Endogenous	Utility for Country II	200

C. Equations

There are 13 equations in total. 4 equations are about the material balance of capital and labor for both countries, and 4 equations are about the production of A and B for each of the two countries. 2 equations are about the tariff and 1 equation is about the balance of trade. The last two equations are about the consumption ratio.

Table 2 Equations definitions

Equations	Definitions
$\mathbf{IAL} + \mathbf{IBL} = \mathbf{20000}$	Material balance of labor for I
$\mathbf{IAK} + \mathbf{IBK} = \mathbf{20000}$	Material balance of capital for I
$\mathbf{IA} = \mathbf{IAL}^{\mathbf{0.4}} \times \mathbf{IAK}^{\mathbf{0.1}}$	Production of A in country I
$\mathbf{IB} = \boldsymbol{IBL}^{\mathbf{0.1}} \times \boldsymbol{IBK}^{\mathbf{0.4}}$	Production of B in country I
$\mathbf{IIAL} + \mathbf{IIBL} = \mathbf{20000}$	Material balance of labor for II
$\mathbf{IIAL} + \mathbf{IIBL} = \mathbf{20000}$	Material balance of capital for II
$\mathbf{IIA} = \boldsymbol{IIAL}^{\mathbf{0.1}} \times \boldsymbol{IIAK}^{\mathbf{0.4}}$	Production of A in country II
$\mathbf{IIB} = \boldsymbol{IIBL}^{\mathbf{0.4}} \times \boldsymbol{IIBK}^{\mathbf{0.1}}$	Production of B in country II
$\mathbf{Ae} = \mathbf{Be} \times \mathbf{P}$	Balance of Trade
$\mathbf{PI} = \mathbf{P}$	Tariff Wedge I
$PII = P \times (1 - Tariff\ \_2)$	Tariff Wedge II
$(\mathbf{IA} - \mathbf{Ae}) \times \mathbf{7} = (\mathbf{IB} + \mathbf{Be}) \times \mathbf{PI} \times \mathbf{3}$	Consumption Ratio I
$(\mathbf{IIB} - \mathbf{Be}) \times \mathbf{7} \times \mathbf{PII} = (\mathbf{IIA} + \mathbf{Ae}) \times \mathbf{3}$	Consumption Ratio II

Objective functions:

Country I and country II maximize their respective utility functions during their own move

- $UI = 2 \times (IA - Ae)^{0.3} \times (IB + Be)^{0.7}$
- $UII = 2 \times (IIA + Ae)^{0.7} \times (IIB - Be)^{0.3}$

III. Simulation Results and Analysis

A. Stage 0, initial endowments

This is a state where each country keeps their initial endowment of labor and capital. No trade takes place at this stage and the utility level is 200 for each country.

Table 3 Results summary at the initial stage

IAK	IBL	IAK	IBK	IIAL	IIBL	IIAK	IIBK
10000	**10000**	**10000**	**10000**	**10000**	**10000**	**10000**	**10000**
IA	IB	IIA	IIB	Ae	Be	UI	UII
100	**100**	**100**	**100**	**0**	**0**	**200**	**200**

B. Stage 1, autarky

At this stage, country I and country II both allocate their own capital and labor respectively into sectors A and B to maximize their own utilities. The two economies are in autarky and no trade happens between two countries.

Table 4 Results summary for utility optimization under autarky

IA	IB	IAL	IBL	IAK	IBK	UI
93.2	**122.9**	**12631.6**	**7368.4**	**1935.5**	**18064.5**	**226.2**
IIA	**IIB**	**IIAL**	**IIBL**	**IIAK**	**IIBK**	**UII**
122.9	**93.2**	**7368.4**	**12631.6**	**18064.5**	**1935.5**	**226.2**

From table 4, both countries achieve higher utility, which are 226.2 for both countries compared to initial utility of 200. Since Country I has better technology in producing A with labor, but better technology in producing B with capital, while country II has better technology in producing A with capital, but better technology in producing B with labor, they allocate their factors of production according to their technologies. Country I allocates more labor to produce A and more capital to produce B, while country II distributes more capital to produce A and more labor to produce A. In this case, Country I produces more of product B, 122.9 and country II produces more of A, 122.9.

C. Stage 2 Free Trade

In this stage, if both countries stick to their production plans under autarky, they would be producing as the following: country I produces 93.17A and 122.88B; and country II produces 122.88A and 93.17. They are allowed to exchange products freely as to maximize their respective utility.

Table 5 Results summary for free trade

UI	UII	Ae	Be	P	PI	PII
234.58	**234.58**	**28.36**	**28.36**	**1**	**1**	**1**

According to table 5, by engaging in international trade, both countries can be better off, which reach higher utility of 234.58, compared to previous 226.2 under autarky case. Under free trade, 28.36 Ae would be exchanged for 28.36 Be.

D. Stage 3 Free Trade, country I allocates resource

Now as a developing country, country I could design an industrial policy by taking into account the industry structure of country II (developed country). In such case, country I allocates even more labor and capital to industry A. Thus, A produced in country I increases and B produced decreases. But through international trade, country I exchanges 31.95A for 30.28B from country II.

Table 6 Results summary for free trade with country I allocating resources

IA	IB	IAL	IBL	IAK	IBK
99.45	**118.96**	**13932.82**	**6067.20**	**2510.24**	**17489.76**
UI	Ae	Be	P	PI	PII
235.25	**31.95**	**30.28**	**1.055**	**1.055**	**1.055**

At stage 3, country I achieves a higher utility as well as country II, with 235.25 for country I and 235.25 for country II.

E. Stage 4-1, country II reacts with imposing tariff

This stage is simulating country II's tariff imposition to country I's industrial policy at stage 3. Although country II has a fixed industry structure, it has been participating in the international market for some years. So country II has experiences in achieving higher utility by imposing imports tariff on country I's products.

Table 7 Results Summary for country II reacting with imposing tariff

Ae	Be	P	PI	PII	Tariff II	UI	UII	U total
23.84	**18.59**	**1.28**	**1.28**	**0.84**	**0.34**	**229.89**	**239.52**	**469.41**

With tariff of 0.34, the relative price in country II becomes 0.84. And country II exchanges 18.59B for 23.84A from country I. In such situation, country II's utility increases to 239.52 and country I's utility decreases to 229.89. Country II is better off at the cost of country I's lower utility.

F. Stage 4-2, country I makes transfer to country II

At the stage 4-1, with price distortion because of country II's imports tariff, country I's utility decreases. However, country I can consider another way to avoid being retaliated by country II. Assuming country I has overseen country II's incoming tariff retaliation, country I can offer to make transfer unconditionally to country II. In the new model, two variables Transfer A and Transfer B are added and consumption ratio constraints are relaxed. Another constraint is utility of country II should not be lower than the utility achieved in stage 4-1.

Table 8 Results summary for country I making direct transfer to country II

Ae	Be	P	UI	UII	Transfer A	Transfer B

33.45	**31.59**	**1.05**	**232.11**	**239.52**	**0**	**2.74**

According to table 8, it shows that, by exchanging 33.45 for 31.59 from country II and making a 2.74 transfer to country II, country I achieves higher utility than stage 4-1, whereas maintaining the utility of country II. Total Utility is 471.63 compared to 469.41 under scenario of optimum tariff in 4-1.

IV. Discussion and conclusion

Figure 2 Utilities of two countries in different stages

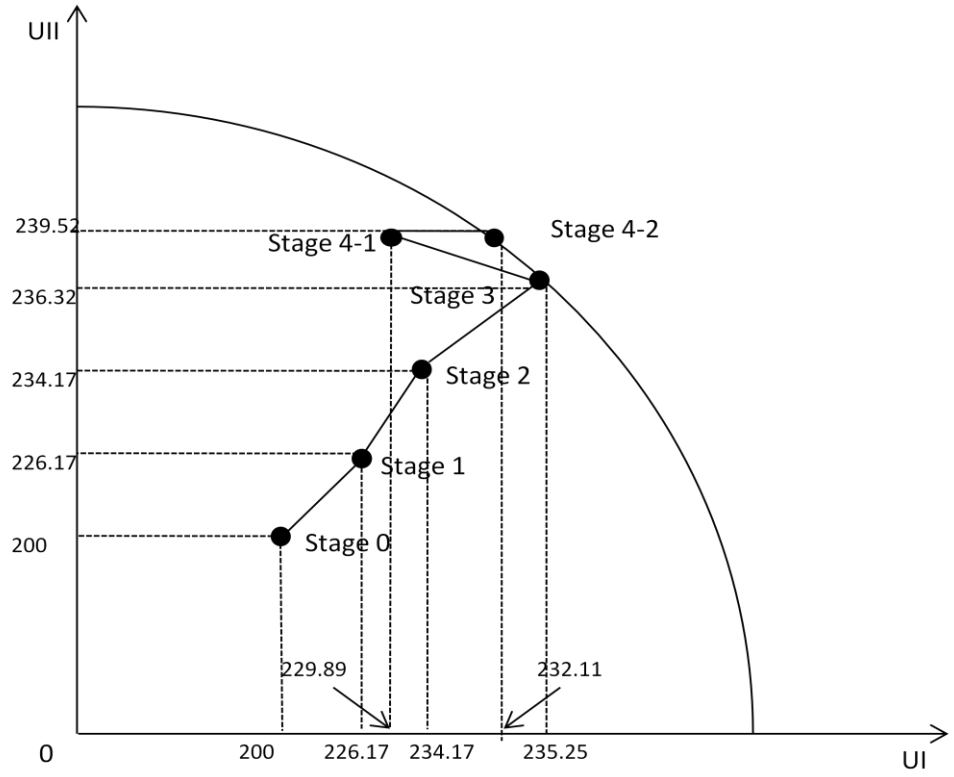


Figure 2 shows utility levels for each country of different stages. Following conclusions are reached by observing each stage above.

i) Free trade can increase utility of both countries.

ii) By designing industrial policy (allocating resources in different sectors), developing country I can achieves even higher utility.

iii) By creating price distortions with tariffs, developed country can achieve higher utility, although its industry structure is fixed as shown in stage 4.

iv) Instead of imposing optimum tariff by country II, country I can offer to make direct transfer of goods to its trade partner. By undertaking this step, it can achieve higher utility whereas not making the other country worse off. In figure 2, the utility level shifts back to the utility possibility frontier.