

H&SS Economics Senior Honors Thesis

Trade Specialization and Welfare Implications for China after WTO Ascension

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Abstract:

Given the rapid growth of the Chinese economy after 1978, the explosive growth of its trade, and its ability to attract record amounts of foreign direct investment, it is apparent that membership in the World Trade Organization is the next step in the country's economic future. China's commitments to further open its economy in order to gain membership in the World Trade Organization are sweeping. They include significant reductions in tariffs that will bring the average level to less than 10 percent by 2005. The broader and deeper commitments China has made inevitably will entail substantial short-term economic costs. While in the medium and long term, the efficiency gains from restructuring the economy can be anticipated to be significant with the reallocation of both labor and capital. This study aims to give an illustrative overview of China's trade development and the possible trade implications with the ascension into WTO and the scenario of 'free trade'. Using a Ricardian model, a model was set up to investigate different scenarios given different changes in certain parameters like consumption preferences, level of technology and more importantly, the reduction in the level of tariffs. The welfare effects on consumers for each scenario is then taken and discussed, giving a certain level of insight on the consequences arising with the changes in China's trade framework.

“International economic cooperation has brought about this defining moment in the history of the multilateral trading system,”

-Mike Moore, WTO Director-General at the conclusion of the meeting of the Working Party on China's Accession , Sept 17 2001

1. Introduction

Trade is the most obvious evidence of globalization with the past 50 years seeing an exceptional growth in world trade. Merchandise exports grew on average by 6% annually. Total trade in 2000 was 22-times the level of 1950¹. Transnational companies, one whose operations cross borders now account for a full one third of world output and two-thirds of world trade. Much is attributed to GATT and the WTO in creating a strong and prosperous trading system.

The system was developed through a series of trade negotiations, or rounds, held under GATT. The first rounds dealt mainly with tariff reductions but later negotiations included other areas such as anti-dumping and non-tariff measures. The 1986-94 Uruguay Round led to the WTO's creation.

The role of WTO soon extended to covering negotiations and other work on non-agricultural tariffs, trade and environment, rules on anti-dumping and subsidies, investment, competition policy, trade facilitation, transparency in government procurement, intellectual property, and a range of issues raised by developing countries as difficulties they face in implementing the present WTO agreements.

¹ World Trade Organization

2. China, US and WTO

Bilateral trade between China and the United States has grown extremely rapidly since trade relations resumed in 1978. According to the US Census, two way trade has risen 50 times from 1979 to 2002. Currently, the US is China's 2nd largest trading partner after Japan, while China is US's 4th biggest trading partner after Canada, Mexico, and Japan.² The existence of such a large trading relationship between China and US implies it would be reasonable to isolate these 2 countries in the world economy and that trade actions by one of these countries would have a direct consequence on the other.

Despite China's extraordinary trading performance, China remained in certain respects only shallowly integrated into the world economy. High tariffs and an array of non-tariff barriers meant that some critical sectors of the Chinese economy remained relatively insulated from international competition. More generally, the state controlled imports by limiting both the type and number of companies authorized to carry out international transactions; imposing onerous inspection and safety licensing requirements on imports; developing technical standards designed in part to protect domestic industries; discriminating against foreign goods in government procurement, and imposing high local content requirements on foreign and joint-venture firms producing in China. And certain sectors of the economy, such as distribution, telecommunications, and financial services, remained entirely or largely closed to foreign direct investment.

As such, China's membership in the WTO is important and positive for all trading partners. For China, admission to the trade organization will guarantee equal trading

² Ministry of Foreign Trade and Economic Cooperation

status with the more than 100 other countries that are already WTO members. That equal trading status is what trade specialists call "most favored nation" status. It means the United States and all other WTO members will be required to treat Chinese products in the same way they treat products from every other country. Thus once China joins the WTO, the tariffs on Chinese goods cannot be higher than the tariffs on the same goods imported from other countries.

3. Tariff reductions in China

China's commitments to further open its economy in order to gain membership in the World Trade Organization are sweeping. They include significant reductions in tariffs that will bring the average level to under 10 percent by 2005; the introduction of a tariff-rate quota system that brings the tariff rate for key agricultural commodities, such as wheat, almost to zero for a significant volume of imports; the gradual elimination of all quotas and licenses that have restricted the flow of some imports; a substantial reduction in the use of state trading as an instrument to control the volume of imports of agricultural and other key commodities; and the opening of critical service sectors such as telecommunications, distribution, banking, insurance, asset management, and securities to foreign direct investment. In addition, the protocol governing its accession sets forth China's commitment to abide by international standards in the protection of intellectual property and to accept the use by its trading partners of a number of unusual mechanisms that could be used to reduce the flow of Chinese goods into foreign markets.

For the purposes of the thesis, we are concern with the tariff situation in China. Of which, certain main tariff reductions are highlighted in the table below.

Import product	Pre-tariff	Post-tariff	Target Date
Industrial goods	24.6%	9.4%	2005
US priority industrial goods	24.6%	7.3%	2003
Information technology	13.3%	0%	2005
Agriculture	31.5%	17%	2004
US priority agriculture goods	31.5%	14.5%	2004
Wood	12%	7.5%	2005
Paper	20%	7.5%	2005
Auto sector	100%	25%	2006

Table 1: China Import Tariff Changes, Source: The White House Office of Public Liaison, 11/17/1999

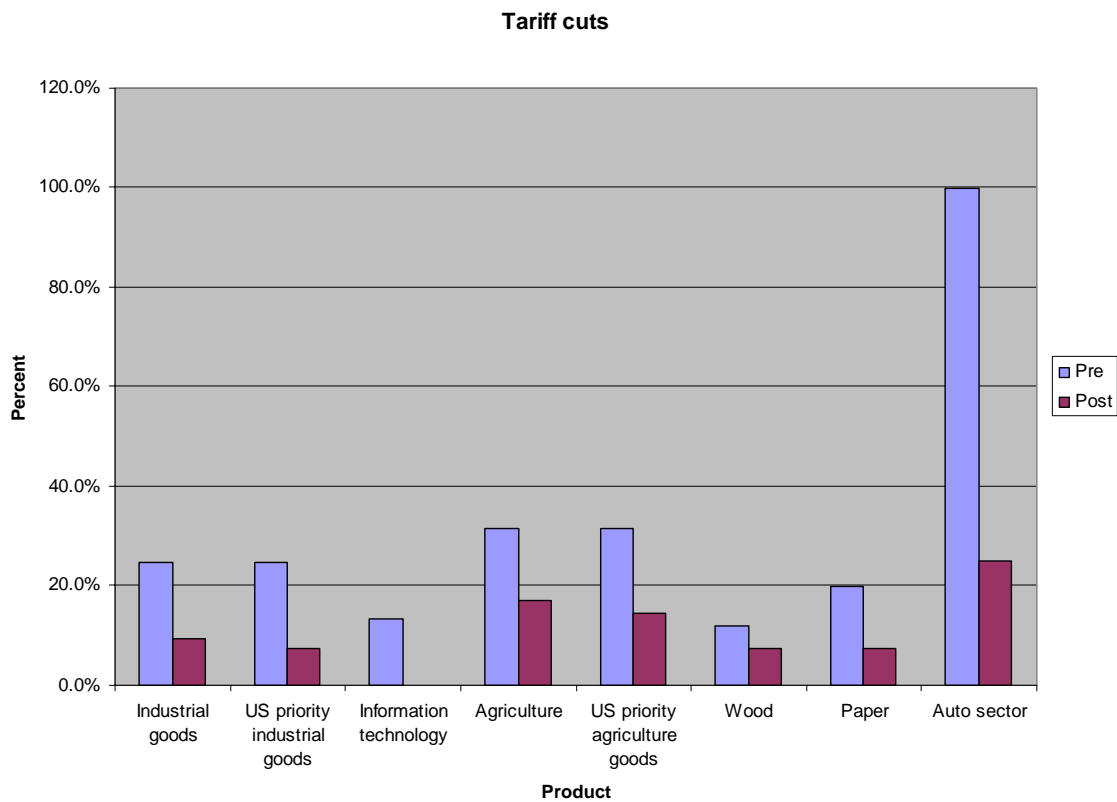


Fig 1: China Import Tariff Changes, Source: The White House Office of Public Liaison, 11/17/1999

For most of the goods, the reductions come up to around a decrease of 50-60% of the original tariffs, and in some cases, the tariffs are totally eliminated.

One of the main skepticism with regards to 'free trade' after China's ascension into WTO was the issue of compliance. But confidence in China's performance has been bolstered when the Office of the U.S. Trade Representative (USTR) reported to the Congress on December 11 2002 that China has made "significant progress" in fulfilling its obligations as a new member of the World Trade Organization (WTO) "although much is left to do." USTR said that Beijing has concentrated its efforts on improving its framework of laws and regulations governing trade in goods and services, at both the central government level and that of local authorities.

As a general matter, China took positive steps to implement many of its specific WTO commitments during the past year. It made required tariff reductions, notably for information technology products, chemicals, autos and auto parts, wood and paper products, and many agricultural goods, including beef, dairy products and citrus, among others³. When discrepancies between committed and implemented rates were reported, China usually made necessary adjustments.

China also began the process of removing numerous non-tariff trade barriers that had affected a range of industries, from chemicals to scientific equipment, and it continued to improve its standards regime. For the most part, these steps were managed without

³ USTR, China WTO Compliance Report, Dec 2002

serious incident, and market access for U.S. products in the affected sectors has generally improved.

4. Ricardian Model revisited

Since one of the major consequences for China is the reduction of tariffs, we are going to use a Ricardian model to assess the impact of import tariffs on consumer welfare and country specialization. To help us thoroughly understand the model, we'll be looking at prices, consumption, resource allocation equilibriums under 3 different scenarios:

- i. Autarky
- ii. Trade
- iii. Trade with tariffs

4.1 Ricardian Model

The modern version of the Ricardian Model assumes that there are two countries, producing two goods, using one factor of production, usually labor. The model is a general equilibrium model in which all markets (i.e., goods and factors) are perfectly competitive. The goods produced are assumed to be homogeneous across countries and firms within an industry. Goods can be costlessly shipped between countries (i.e., there are no transportation costs). Labor is homogeneous within a country but may have different productivities across countries. This implies that the production technology is assumed to differ across countries. Labor is costlessly mobile across industries within a country but is immobile across countries. Full employment of labor is also assumed. Consumers (the laborers) are assumed to maximize utility subject to an income constraint.

A country has a comparative advantage in the production of a good if it can produce that good at a lower opportunity cost relative to another country. The Ricardian model states that countries would produce goods that they have a comparative advantage in, and trade for the goods they do not produce. And in so doing, total welfare of all countries would increase compare to the previous state of autarky.

4.2 General Equilibrium Model : 2 good, 1 factor country in autarky

Consumer

Let consumer preferences be Cobb-Douglas and described by the following function

$$u(c_c, c_w) = c_c^\alpha c_w^{1-\alpha}$$

On the consumer side, they face a budget constrain which is described by the price of the good, the consumption of the good and the total amount of labor and wage rate of the given economy.

$$p_c c_c + p_w c_w = Lw$$

$$\Rightarrow \frac{p_c c_c}{w} + \frac{p_w c_w}{w} = L$$

Firm

The firm's production is limited by the amount of labor as well as the level of technology of the industry.

Production amount

$$y_c = a_c l_c \text{ and } y_w = a_w l_w$$

Level of profits

$$\begin{aligned}
 \pi_c &= p_c y_c - w l_c \\
 &= p_c a_c l_c - w l_c \\
 &= l_c (p_c a_c - w)
 \end{aligned}$$

Since we assume the markets are to be competitive, there are zero profits in the industry.

$$\begin{aligned}
 \pi_c &= 0, l_c \neq 0 \\
 \Rightarrow (p_c a_c - w) &= 0 \\
 \Rightarrow \frac{p_c}{w} &= \frac{1}{a_c}
 \end{aligned}$$

likewise,

$$\frac{p_w}{w} = \frac{1}{a_w}$$

As such we find that the prices of the goods are only subjected to the level of the technology in the industry.

To find out the level of labor allocation and consumption of the 2 goods in autarky, let's maximize the consumer's utility given the budget constrain and the known prices of the goods.

Budget constrain

$$\begin{aligned}
 \frac{p_c c_c}{w} + \frac{p_w c_w}{w} &= L \\
 \frac{c_c}{a_c} + \frac{c_w}{a_w} &= L
 \end{aligned}$$

$$\max u(c_c, c_w)$$

$$\Rightarrow c_w = a_w(1-\alpha)L, c_c = a_c\alpha L$$

Assuming market equilibrium position where there is no excess capacity in the economy and the amount of labor is fixed.

$$l_w + l_c = L$$

$$y_c = c_c$$

$$y_w = c_w$$

We are able to determine the production, consumption and allocation of labor resources to the 2 goods. Prices if normalized to the wage rate would be as follows:

$$y_c = c_c = a_c\alpha L \quad (4.2a)$$

$$y_w = c_w = a_w(1-\alpha)L \quad (4.2b)$$

$$l_c = \alpha L \quad (4.2c)$$

$$l_w = (1-\alpha)L \quad (4.2d)$$

$$p_w = \frac{1}{a_w}, w=1 \quad (4.2e)$$

$$p_c = \frac{1}{a_c}, w=1 \quad (4.2f)$$

4.3 General Equilibrium Model : 2 countries, 2 goods, 1 factor in free trade**Consumer**

For country A, the utility preference would be $u_A(c_c, c_w) = c_{Ac}^\alpha c_{Aw}^{1-\alpha}$, while for

country B, it would be $u_B(c_c, c_w) = c_{Bc}^\beta c_{Bw}^{1-\beta}$.

The budget constraints on these 2 countries are given to be

$$p_c c_{Ac} + p_w c_{Aw} = L_A w_A \text{ and } p_c c_{Bc} + p_w c_{Bw} = L_B w_B$$

To determine the consumption amounts of the consumers, let's maximize each utility function given that the prices of cheese and wine are already predetermined. The detailed general proof of the results is given in the appendix.

$$c_{Ac} = \frac{\alpha L_A w_A}{p_c} \quad (4.3a)$$

$$c_{Aw} = \frac{(1-\alpha) L_A w_A}{p_w} \quad (4.3b)$$

$$c_{Bc} = \frac{\beta L_B w_B}{p_c} \quad (4.3c)$$

$$c_{Bw} = \frac{(1-\beta) L_B w_B}{p_w} \quad (4.3d)$$

Firm

Production of the goods in the 2 countries are given by

$$y_{Ac} = a_{Ac} l_{Ac}, y_{Aw} = a_{Aw} l_{Aw}, y_{Bc} = a_{Bc} l_{Bc}, y_{Bw} = a_{Bw} l_{Bw}$$

Suppose that $\frac{a_{Ac}}{a_{Aw}} < \frac{a_{Bc}}{a_{Bw}}$, this implies that Country A has better technology in

producing wine, hence it has a comparative advantage in producing wine. Country B has a relative higher technology of cheese to wine, thus has a comparative advantage in producing cheese to wine.

In such an event, the autarky price of cheese in A would be more expensive than the price of cheese in B, while the autarky price of wine in A would be cheaper than the price of wine in B. We could see that if country A has better technology in producing wine, then the relative prices of cheese in terms of local wine would be more expensive for A then it is for country B.

$$p_{Ac} = \frac{w_A}{a_{Ac}}, p_{Aw} = \frac{w_A}{a_{Aw}}, p_{Bc} = \frac{w_B}{a_{Bc}}, p_{Bw} = \frac{w_B}{a_{Bw}}$$

$$\frac{p_{Ac}}{p_{Aw}} = \frac{a_{Aw}}{a_{Ac}}, \frac{p_{Bc}}{p_{Bw}} = \frac{a_{Bw}}{a_{Bc}}$$

$$\frac{p_{Ac}}{p_{Aw}} > \frac{p_{Bc}}{p_{Bw}} \Leftrightarrow \frac{a_{Aw}}{a_{Ac}} > \frac{a_{Bw}}{a_{Bc}} \Leftrightarrow \frac{a_{Ac}}{a_{Aw}} < \frac{a_{Bc}}{a_{Bw}}$$

Given that Country A having higher relative cheese prices as compared to B, we can see that with free trade the new traded relative cheese prices would intuitively be between A and B prices, otherwise there is no motivation for trade.

The proof is as follows, if traded prices are higher than local relative prices of cheese, then the country would specialize in cheese.

$$\frac{p_c}{p_w} > \frac{p_{Bc}}{p_{Bw}} \Leftrightarrow \frac{p_c}{p_w} > \frac{a_{Bw}}{a_{Bc}} \Leftrightarrow p_c a_{Bc} > p_w a_{Bw}$$

$$l(p_c a_{Bc} - w) > l(p_w a_{Bw} - w) \Rightarrow \pi_c > \pi_w$$

We know that in a competitive industry, there are zero profits to be made, thus $\pi_c = 0$, and $\pi_w < 0$. Hence, since the wine industry is making a loss, country B would specialize

in cheese. Using this same argument, if $\frac{p_c}{p_w} > \frac{p_{Ac}}{p_{Aw}} > \frac{p_{Bc}}{p_{Bw}}$, then both countries

would produce cheese, and there is no basis of trade, which is a contradiction. Likewise

for $\frac{p_{Ac}}{p_{Aw}} > \frac{p_{Bc}}{p_{Bw}} > \frac{p_c}{p_w}$ where both would produce wine. $\frac{p_{Ac}}{p_{Aw}} > \frac{p_c}{p_w} > \frac{p_{Bc}}{p_{Bw}}$ is

hence the only logical relationship

Since there are negative profits in the cheese industry in A and wine industry in B, the countries would thus specialize in the product of their comparative advantage as proven in the Ricardian model. Labor allocation is also predetermined with specialization.

$$l_{Ac} = 0, l_{Aw} = L_A, l_{Bc} = L_B, l_{Bw} = 0$$

And though Country A is specializing in wine, the market is still perfectly competitive and there are zero profits in the industry, while there are no profits in the cheese market

$$\text{in Country B. Hence, } p_w a_{Aw} - w_A = 0 \Rightarrow \frac{p_w}{w_A} = \frac{1}{a_{Aw}} \quad (4.d),$$

$$\text{likewise } \frac{p_c}{w_B} = \frac{1}{a_{Bc}} \quad (4.3e).$$

General equilibrium

Assuming that there is no excess capacity, where production = consumption, then

$$a_{Bc}L_B = c_{Ac} + c_{Bc} \quad (4.3f)$$

Making the substitution from 4.3e to 4.3c gives

$$c_{Bc} = \beta a_{Bc}L_B \quad (4.3g)$$

Using 4.3f and 4.3g, we get

$$c_{Ac} = (1 - \beta)a_{Bc}L_B \quad (4.3h)$$

Likewise,

$$c_{Aw} = (1 - \alpha)L_A a_{Aw} \quad (4.3i)$$

$$c_{Bw} = \alpha a_{Aw}L_A \quad (4.3j)$$

At this point we have figured out the consumption choices of the consumers, which interestingly is a function of the Cobb-Douglas coefficient, the level of technology and the total amount of labor.

To solve for the wage rate of Country A, we just have to use the budget constrain of A.

$p_c c_{Ac} + p_w c_{Aw} = L_A w_A$ and using 4.3a and 4.3b, we solve for wage rate to be

$$w_A = \frac{(1 - \beta)L_B}{\alpha L_A} \quad (4.3k)$$

With the consumption patterns, we can finally look at what the free trade prices of cheese and wine should be. If we take the prices of all goods to be relative to the wage rate in country B, then the prices, consumption, production and labor allocation choices are as summarized:

$$l_{Ac} = l_{Bw} = 0$$

$$l_{Bc} = L_B$$

$$l_{Aw} = L_A$$

$$y_c = a_{Bc} L_B$$

$$y_w = a_{Aw} L_A$$

$$p_c = \frac{w_B}{a_{Bc}} = \frac{1}{a_{Bc}}$$

$$p_w = \frac{w_A}{a_{Aw}}$$

$$c_{Bc} = \frac{\beta L_B w_B}{p_c} = \beta L_B a_{Bc}$$

$$c_{Ac} = \frac{\alpha L_A w_A}{p_c} = (1 - \beta) L_B a_{Bc}$$

$$c_{Aw} = \frac{(1 - \alpha) L_A w_A}{p_w} = (1 - \alpha) L_A a_{Aw}$$

$$c_{Bw} = \frac{(1 - \beta) L_B w_B}{p_w} = \alpha L_A a_{Aw}$$

$$w_A = \frac{(1 - \beta) L_B}{\alpha L_A}$$

4.4 General Equilibrium Model : 2 countries, 2 goods, 1 factor in trade with tariff.

For simplicity purpose, let's assume that tariff is only on one good on one country. But the framework could be later extended to tariffs on both goods on both countries.

Let there be a given tax rate of 't' on all cheese imports from Country B imposed by Country A.

Consumers

Consumption choice would also slightly different compared to the free trade situation.

For country A, the utility preference would be $u_A(c_c, c_w) = c_{Ac}^\alpha c_{Aw}^{1-\alpha}$, while for

country B, it would be $u_B(c_c, c_w) = c_{Bc}^\beta c_{Bw}^{1-\beta}$.

The budget constraints on these 2 countries are given to be

$$p_c c_{Ac} (1+t) + p_w c_{Aw} = L_A w_A + T \quad \text{and} \quad p_c c_{Bc} + p_w c_{Bw} = L_B w_B .$$

$T = p_c c_{Ac} t$ is a lump sum subsidy given back to the economy so that a

general equilibrium exists. To determine the consumption amounts of the consumers, let's maximize each utility function given that the prices of cheese and wine are already predetermined.

$$\begin{aligned}
c_{Ac} &= \frac{\alpha(L_A w_A + T)}{(1+t)p_c} = \frac{\alpha(L_A w_A + p_c c_{Ac} t)}{(1+t)p_c} \\
&= \frac{\alpha L_A w_A}{(1+t - \alpha t)p_c} \tag{4.4a}
\end{aligned}$$

$$\begin{aligned}
c_{Aw} &= \frac{(1-\alpha)(L_A w_A + T)}{p_w} = \frac{(1-\alpha)(L_A w_A + p_c c_{Ac} t)}{p_w} \\
&= \frac{(1-\alpha)(L_A w_A + \frac{\alpha L_A w_A}{(1+t - \alpha t)} t)}{p_w} = \frac{L_A w_A (1+t)(1-\alpha)}{p_w (1+t - \alpha t)} \tag{4.4b}
\end{aligned}$$

$$c_{Bc} = \frac{\beta L_B w_B}{p_c} \tag{4.4c}$$

$$c_{Bw} = \frac{(1-\beta)L_B w_B}{p_w} \tag{4.4d}$$

Firms

Taking that country A is still specializing in wine and there is trade, then there are zero profits in A's wine industry, while there are no profits in the cheese market in Country B.

$$\text{Hence, } p_w a_{Aw} - w_A = 0 \Rightarrow \frac{p_w}{w_A} = \frac{1}{a_{Aw}} \tag{4.4e}, \text{ likewise}$$

$$\frac{p_c}{w_B} = \frac{1}{a_{Bc}} \tag{4.4f}.$$

General equilibrium

Using the above equations and the fact that total production = total consumption, we could determine the exogenous variable wage rate of country A if all prices are normalized to the wage rate of country B.

Using the equilibrium condition for the cheese industry , 4.4a, 4.4b and 4.4f

$$c_{Ac} + c_{Bc} = y_c$$

$$\frac{\alpha L_A w_A}{(1+t-\alpha t)p_c} + \frac{\beta L_B w_B}{p_c} = a_{Bc} L_B$$

$$\frac{p_c}{w_B} = \frac{1}{a_{Bc}}, w_B = 1 \Rightarrow w_A = \frac{[1+(1-\alpha)t](1-\beta)L_B}{\alpha L_A}$$

Using the equilibrium for the wine industry would lead to the same results for the wage rate of country A.

4.5 Effect of tariff increase

We can see from the equation above that the wage rate of country A varies proportionately with the tax rate as all other variables are exogenous constants. And as the wine industry has to make zero profits, the rise in wage rates is accompanied by the rise in price of wine for the zero profit condition to hold.

This relationship in short is represented by the below statement:

$$t \uparrow \Rightarrow p_w \uparrow, w_A \uparrow, p_c \leftrightarrow, w_B = 1$$

Intuitively, this makes sense as the total production of cheese remains constant, and the price of the cheese normalized to the wage rate of country B is also constant, hence the demand of the cheese from country B is also held constant. Since the world is held in equilibrium, the demand of country A has to be held constant as well.

$$t \uparrow \Rightarrow y_c \leftrightarrow, c_{Ac} \leftrightarrow, c_{Bc} \leftrightarrow$$

In the wine industry, we know that the supply of wine is constant. But because wine prices have been raised, consumption of wine in country B will drop but this drop is matched by a corresponding rise in wine consumption by country A.

$$t \uparrow \Rightarrow y_w \leftrightarrow, c_{Aw} \uparrow, c_{Bw} \downarrow$$

Country B starts producing wine!

With the gradual increase in the price of wine, there comes the possibility that it might be profitable for Country B to start producing wine as well. Let us assume that such a possibility actually exists and that Country B produces 2 goods, hence, since the wine industry has to earn zero profits, the following condition has to hold true.

$$p_w = \frac{w_B}{a_{Bw}} = \frac{w_A}{a_{Aw}}$$

Assuming also that Country B dedicates k_w amount of its total labor to producing wine ($k_w < 1$), we could use the market clearing condition of the wine industry to find out what

k_w is $c_{Aw} + c_{Bw} = k_w L_B a_{Bw} + a_{Aw} L_A$. Using substitutions from 4.4b, 4.4d, 4.4e

and 4.4f:

$$\frac{L_A w_A (1+t)(1-\alpha)}{p_w (1+t-\alpha t)} + \frac{(1-\beta)L_B w_B}{p_w} = k_w L_B a_{Bw} + a_{Aw} L_A$$

$$\frac{w_A}{p_w} = a_{Aw}, \frac{w_B}{p_w} = a_{Bw} \Rightarrow$$

$$\frac{L_A a_{Aw} (1+t)(1-\alpha)}{(1+t-\alpha t)} + (1-\beta)L_B a_{Bw} = k_w L_B a_{Bw} + a_{Aw} L_A$$

solving for k_w , we get

$$k_w = (1 - \beta) - \frac{L_A a_{Aw} \alpha}{L_B a_{Bw} [1 + (1 - \alpha)t]} \quad (4.4g)$$

We can clearly see that as the tariff rate increases, the proportion of labor in Country B dedicated to producing wine increases as well.

But note that this occurs only when the tariff rate is high enough and crosses the threshold of t^* . At t^* , $k_w = 0$.

$$(1 - \beta) - \frac{L_A a_{Aw} \alpha}{L_B a_{Bw} [1 + (1 - \alpha)t^*]} = 0$$

$$t^* = \frac{L_A a_{Aw} \alpha - (1 - \beta) L_B a_{Bw}}{(1 - \alpha)(1 - \beta) L_B a_{Bw}}$$

Looking at the changes in consumption patterns, when the tariff rate increases, total wine production in the world increases, wine consumption in country B remains constant while wine consumption in Country A increases.

$$t > t^*, t \uparrow \Rightarrow y_w \uparrow, c_{Aw} \uparrow, c_{Bw} \leftrightarrow$$

It would also be interesting to note the effect of wages on Country A when the high tariffs push Country B to start producing wine. This could be done by examining the market clearing condition for cheese.

$$c_{Ac} + c_{Bc} = (1 - k_w) L_B a_{Bc}$$

Making the substitutions from 4.4a, 4.4c, 4.4e, 4.4f, we get

$$\frac{\alpha L_A w_A a_{Bc}}{(1 + t - \alpha t)} + \beta L_B a_{Bc} = (1 - k_w) L_B a_{Bc} .$$

Solving for w_A and then doing a substitution for k_w from equation 4.4g,

$$\begin{aligned}
 w_A &= \frac{(1+t-\alpha t)(1-\beta-k_w)L_B}{\alpha L_A} \\
 &= \frac{(1+t-\alpha t)\left\{1-\beta-\left[(1-\beta)-\frac{L_A a_{Aw} \alpha}{L_B a_{Bw}[1+(1-\alpha)t]}\right]\right\}L_B}{\alpha L_A} \\
 &= \frac{a_{Aw}}{a_{Bw}}
 \end{aligned}$$

We can see that once $t > t^*$, the wage rate of Country A would hit a maximum and stay at the constant rate of the ratio of the wine technologies of the 2 countries. This intuitively

is correct as previously we have seen that $p_w = \frac{w_A}{a_{Aw}} = \frac{w_B}{a_{Bw}} (= \frac{1}{a_{Bw}})$, which also

points to the fact that wage rate of Country A has to remain constant. Thus in terms of prices and wages, when $t > t^*$, all prices and wage stay the same.

$$t > t^*, t \uparrow \Rightarrow p_w \leftrightarrow, w_A \leftrightarrow, p_c \leftrightarrow, w_B = 1$$

While in the area of cheese consumption, cheese production would keep decreasing as a greater proportion of labor is shifted to producing wine. Cheese consumption in Country B would remain the same while in Country A, cheese consumption would start dropping.

$$t > t^*, t \uparrow \Rightarrow y_c \downarrow, c_{Ac} \downarrow, c_{Bc} \leftrightarrow$$

The final question to ask is what happens when there is total taxation on the cheese imports?

$$t \rightarrow \infty$$

$$k_w = (1 - \beta) - \frac{L_A a_{Aw} \alpha}{L_B a_{Bw} [1 + (1 - \alpha)t]}$$

$$\rightarrow (1 - \beta) - 0 = (1 - \beta)$$

Interestingly, we could see that both countries have reverted almost to a state of autarky. Country B is in a position very much like when it was in the state of autarky, putting $(1 - \beta)$ amount of its labor in wine production and β in cheese production, and with the consumption patterns of the consumers in Country B very much similar to the situation when there was no trade. Country B imports minimal wine from Country A, and exports minimal cheese. There would be very little cheese consumption in Country A and instead, consumers in Country A would consume almost all the wine which they produce.

4.6 Model Conclusions

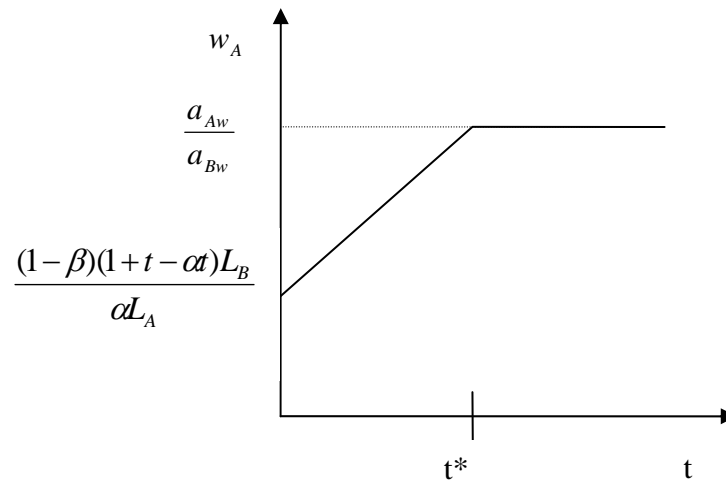
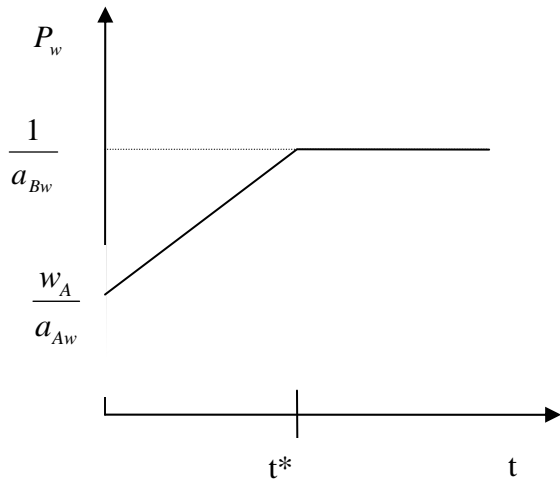
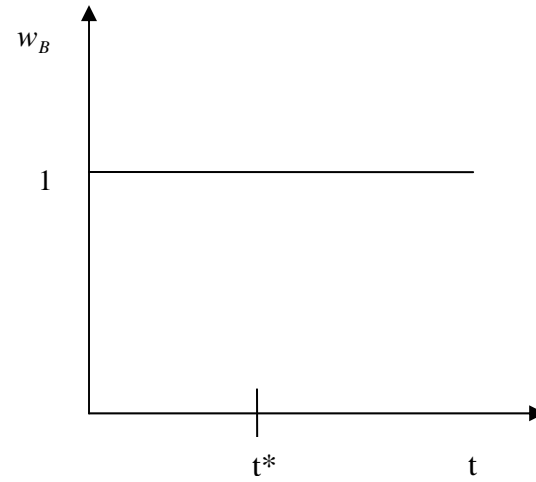
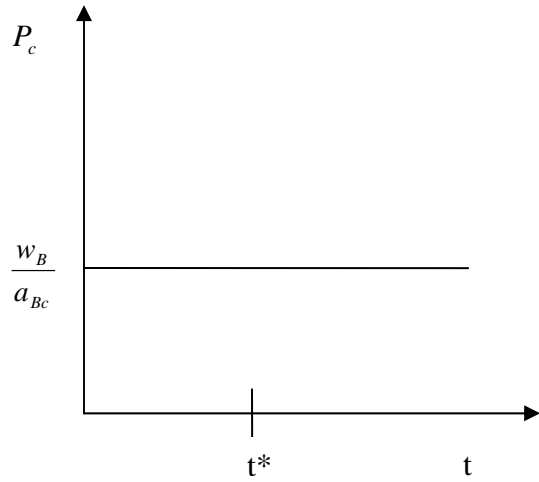
Effect of 1-Country, 1-Good taxation on a 2-Country, 2-Good Ricardian Model

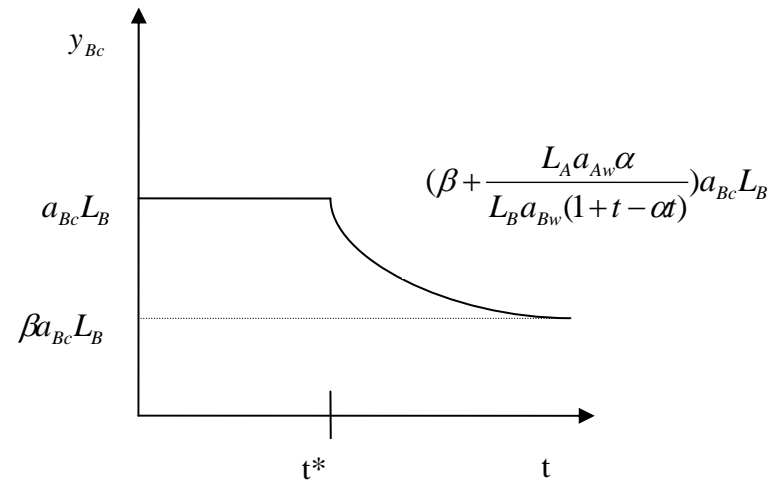
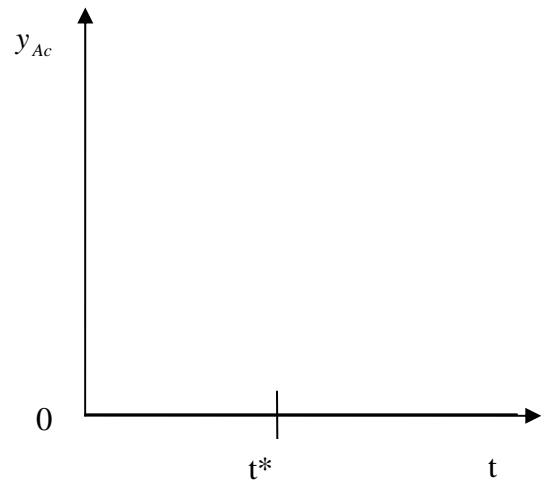
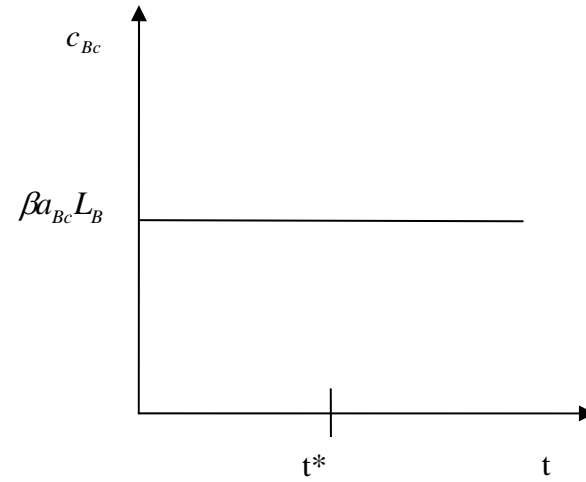
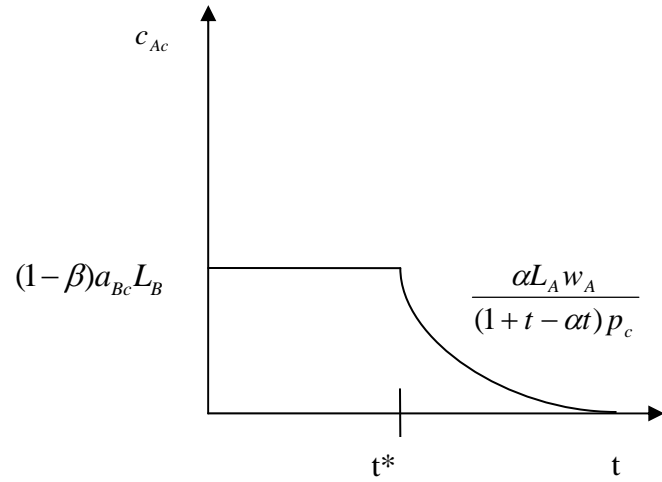
Given a taxation on cheese imports from Country B to Country A

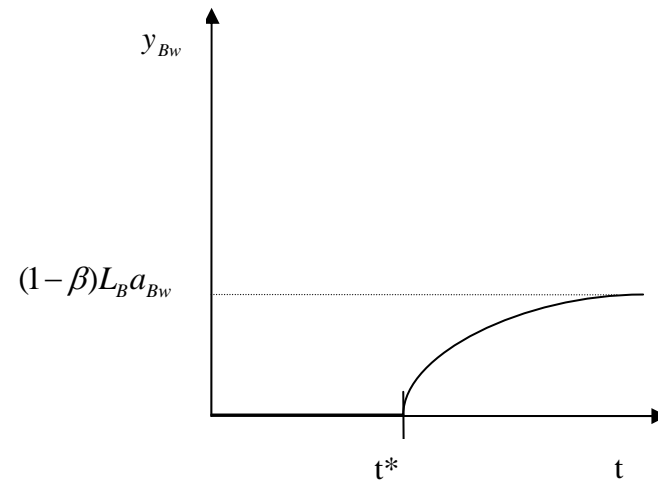
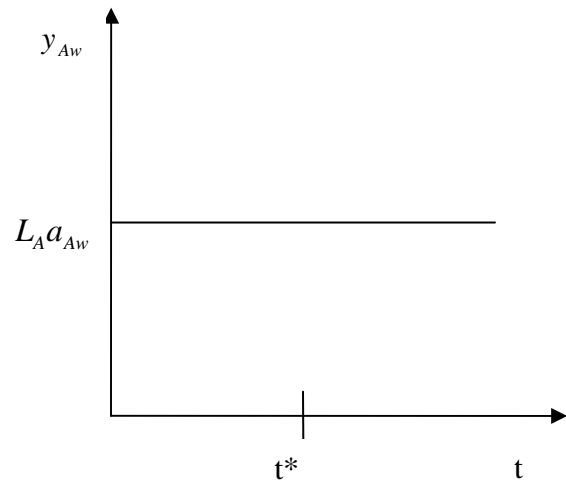
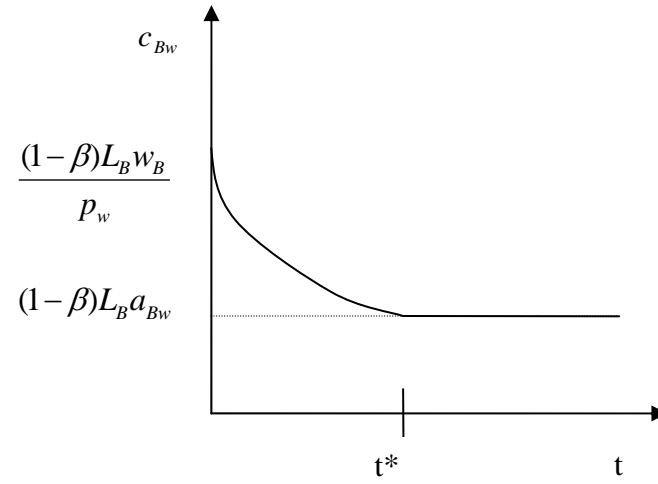
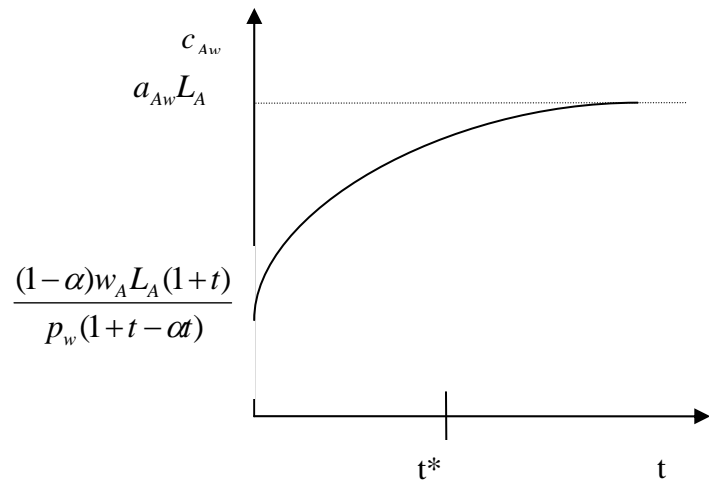
Summary of findings

Variables	$t=0$	$0 < t < t^*$	$t > t^*$	$t \rightarrow \infty$
P_c	\leftrightarrow	\leftrightarrow	\leftrightarrow	\leftrightarrow
P_w	\leftrightarrow	\leftrightarrow	\leftrightarrow	\leftrightarrow
<i>Country A</i>				
w_A	\leftrightarrow	\uparrow	\leftrightarrow	\leftrightarrow
c_{Ac}	\leftrightarrow	\leftrightarrow	\downarrow	0
c_{Aw}	\leftrightarrow	\uparrow	\uparrow	\uparrow
y_{Ac}	0	0	0	0
y_{Aw}	\leftrightarrow	\leftrightarrow	\leftrightarrow	\leftrightarrow
<i>Country B</i>				
w_B	\leftrightarrow	\leftrightarrow	\leftrightarrow	\leftrightarrow
c_{Bc}	\leftrightarrow	\leftrightarrow	\leftrightarrow	\leftrightarrow
c_{Bw}	\leftrightarrow	\downarrow	\leftrightarrow	\leftrightarrow
y_{Bc}	\leftrightarrow	\leftrightarrow	\downarrow	\leftrightarrow
y_{Bw}	0	0	\uparrow	\leftrightarrow

The above results could be graphically shown by the plots below:







4.7 Welfare Analysis

Trade vs autarky

Let us now look at the consumption patterns in autarky and trade, and basing on which, we could draw conclusions on whether trade is actually beneficial or not.

In autarky

$$(4.2a) c_{Ac} = \alpha a_{Ac} L_A$$

$$c_{Bc} = \beta a_{Bc} L_B$$

$$(4.2b) c_{Aw} = (1 - \alpha) a_{Aw} L_A$$

$$c_{Bw} = (1 - \beta) a_{Bw} L_B$$

In trade

$$(4.3a) c_{Ac} = (1 - \beta) a_{Bc} L_B$$

$$(4.3c) c_{Bc} = \beta a_{Bc} L_B$$

$$(4.3b) c_{Aw} = (1 - \alpha) a_{Aw} L_A$$

$$(4.3d) c_{Bw} = \alpha a_{Aw} L_A$$

Consumers in Country A enjoy an increase in utility if the amount of cheese consumed in after trade is higher than before. Likewise, consumers in Country B enjoy higher utility after trade if amount of wine consumed after trade is higher than in autarky.

Country A has higher utility

$$\Leftrightarrow (1 - \beta) a_{Bc} L_B > \alpha a_{Ac} L_A$$

$$\Leftrightarrow \frac{(1 - \beta) L_B}{\alpha L_A} > \frac{a_{Ac}}{a_{Bc}} \quad (4.7a)$$

Note that if there is trade, this condition for the firms have to hold

$$p_c a_{Bc} - w_B = 0 \Rightarrow p_c = \frac{w_B}{a_{Bc}}$$

$$p_c a_{Ac} - w_A < 0$$

$$\Rightarrow p_c < \frac{w_A}{a_{Ac}} \Rightarrow \frac{w_B}{a_{Bc}} < \frac{w_A}{a_{Ac}} \Leftrightarrow \frac{a_{Ac}}{a_{Bc}} < \frac{w_A}{w_B}$$

And from equation 4.3k where $w_A = \frac{(1-\beta)L_B}{\alpha L_A}$, and since wages are normalized to wage

rate in Country B, $\frac{w_A}{w_B} = \frac{(1-\beta)L_B}{\alpha L_A}$, we could see that 4.7b is always true.

Country B has higher utility when

$$\begin{aligned} &\Leftrightarrow \alpha a_{Aw} L_A > (1-\beta) a_{Bw} L_B \\ &\Leftrightarrow \frac{a_{Aw}}{a_{Bw}} > \frac{(1-\beta)L_B}{\alpha L_A} \end{aligned} \quad (4.7b)$$

Likewise,

$$p_w a_{Aw} - w_A = 0 \Rightarrow p_w = \frac{w_A}{a_{Aw}}$$

$$p_w a_{Bw} - w_B < 0$$

$$\Rightarrow p_w < \frac{w_B}{a_{Bw}} \Rightarrow \frac{w_A}{a_{Aw}} < \frac{w_B}{a_{Bw}} \Leftrightarrow \frac{w_A}{w_B} < \frac{a_{Aw}}{a_{Bw}}$$

And from equation 4.3k, and since wages are normalized to wage rate in Country B, we could see that 4.7b is always true.

Hence, with 4.7a and 4.7 b true, we could see that when there is trade based on

comparative advantage, both countries are proven to benefit from increased utility!

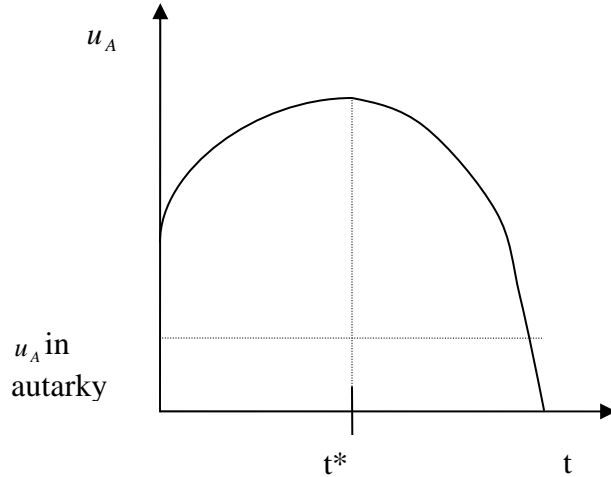
Welfare effects with increasing tariffs

For consumers in Country A, we could see that for $t < t^*$, cheese consumption stays constant while wine consumption increases. This implies that the utility of consumers in Country A would be increasing for $t < t^*$. For $t > t^*$, we can take a look at the derivative of utility.

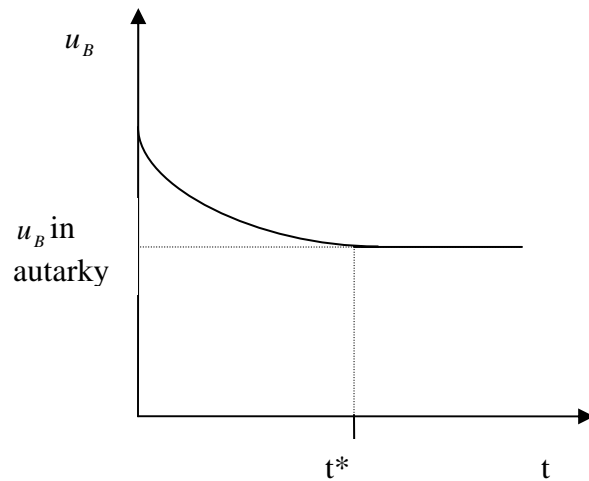
$$\begin{aligned}
 u_A &= \left[\frac{\alpha L_A w_A}{p_c (1+t-\alpha t)} \right]^\alpha \left[\frac{(1+t)(1-\alpha) a_{Aw} L_A}{(1+t-\alpha t)} \right]^{1-\alpha} \\
 &= \left(\frac{\alpha L_A w_A}{p_c} \right)^\alpha (a_{Aw} L_A)^{1-\alpha} \frac{[(1+t)(1-\alpha)]^{1-\alpha}}{(1+t-\alpha t)} \\
 &= K \frac{[(1+t)(1-\alpha)]^{1-\alpha}}{(1+t-\alpha t)}, \quad K = \left(\frac{\alpha L_A w_A}{p_c} \right)^\alpha (a_{Aw} L_A)^{1-\alpha} \\
 \frac{du_A}{dt} &= K \frac{(1-\alpha)[(1+t)(1-\alpha)]^{-\alpha} (1-\alpha)(1+t-\alpha t) - (1-\alpha)[(1+t)(1-\alpha)]^{1-\alpha}}{(1+t-\alpha t)^2} \\
 &= K \frac{(1-\alpha)[(1+t)(1-\alpha)]^{-\alpha} [-\alpha(1-\alpha)t]}{(1+t-\alpha t)^2} < 0 \Leftrightarrow 0 < \alpha < 1
 \end{aligned}$$

Beyond t^* , the shape of the utility function is downward sloping, hence the overall

function could be approximated as follows:



For Country B when $t < t^*$, the consumption of wine keeps decreasing while the consumption of cheese stays constant. Hence the level of utility in B would be decreasing. When $t > t^*$, the amount of cheese consumption and wine consumption stay constant and so would the utility. The utility function would resemble something like the plot below:



Interestingly, Country A would have the incentive to impose tariffs as this increases the level of utility of consumers in Country A until the point t^* . Country B consumers on the other hand suffer from the tariffs until the point t^* .

4.8 Compensating variation

The final point to look at is the concept of compensating variation. That is, could Country B give a portion of its national income such that Country A charges $t=0$ as the utility that Country A gets from that additional income equate to the same amount of utility from charging t^* ? And in giving away a fraction of the income, Country B would still enjoy a higher utility than the case when Country A charges t^* ?

The budget line of such a scenario would hence look like

$$p_c c_{Ac} + p_w c_{Aw} = w_A L_A + m_c w_B L_B$$

$$p_c c_{Bc} + p_w c_{Bw} = (1 - m_c) w_B L_B$$

where m_c is the amount of national income Country B transfers to Country A for not imposing tariffs.

Let u'_A be the amount of utility that Country A consumers get with the additional income, and u^*_A when $t=t^*$. Likewise let u'_B be the utility that consumers in Country B get after giving the additional income and u^*_B when $t=t^*$.

And we would want

$$u'_A = u^*_A$$

$$u'_B > u^*_B$$

If we were to look at the consumption patterns in Country B, we could observe a relationship between u'_B and u^*_B .

$$c_{Bc}^* = \beta a_{Bc} L_B \quad c_{Bw}^* = \frac{(1-\beta)L_B w_B}{p_w^*}$$

$$u_B^* = (c_{Bc}^*)^\beta (c_{Bw}^*)^{1-\beta}$$

$$c'_{Bc} = \beta a_{Bc} L_B (1-m_c) \quad c'_{Bw} = \frac{(1-\beta)(1-m_c)L_B w_B}{p_w^0}$$

$$a_{Aw} = \frac{p_w^0}{w_A^0} = \frac{p_w^*}{w_A^*} \Rightarrow c'_{Bw} = \frac{(1-\beta)(1-m_c)L_B w_A^*}{p_w^* w_A^0}$$

$$u'_B = (c'_{Bc})^\beta (c'_{Bw})^{1-\beta} = (c_{Bc}^* (1-m_c))^\beta (c_{Bw}^* \frac{(1-m_c)w_A^*}{w_A^0})^{1-\beta}$$

$$= u_B^* (1-m_c) \left(\frac{w_A^*}{w_A^0}\right)^{1-\beta}, \quad \frac{w_A^*}{w_A^0} = \frac{a_{Aw} \alpha L_A}{a_{Bw} (1-\beta) L_B} > 1$$

For the compensating variation to exist, so long as consumers in Country B place some utility on wine, decrease in overall consumption is offset by the more than proportionate gain in utility from increased wine consumption.

If consumers in Country B place some importance on wine

$$1 - \beta = \varepsilon$$

$$\frac{w_A^*}{w_A^0} > 1 \Rightarrow \left(\frac{w_A^*}{w_A^0}\right)^{1-\beta} = \left(\frac{w_A^*}{w_A^0}\right)^\varepsilon \approx 1 + \varepsilon$$

$$u'_B > u_B^* \Leftrightarrow (1-m_c) \left(\frac{w_A^*}{w_A^0}\right)^{1-\beta} \geq 1$$

$$\Rightarrow (1-m_c)(1+\varepsilon) \geq 1$$

$$\Rightarrow m_c \leq 1 - \frac{1}{1+\varepsilon} \approx \varepsilon$$

there would exist a level of transfer payment that Country B is willing to undertake so that their level of utility increases.

Similarly, we can compare u'_A and u^*_A .

$$c^*_{Ac} = y_c - c^*_{Bc} \quad c^*_{Aw} = y_w - c^*_{Bw}$$

$$u^*_A = (y_c - c^*_{Bc})^\alpha (y_w - c^*_{Bw})^{1-\alpha}$$

$$c'_{Bc} = c^*_{Bc} (1 - m_c) \quad c'_{Bw} = c^*_{Bw} \frac{(1 - m_c)w^*_A}{w^0_A}$$

$$c'_{Ac} = y_c - c'_{Bc} = y_c - c^*_{Bc} (1 - m_c)$$

$$c'_{Aw} = y_w - c'_{Bw} = y_w - c^*_{Bw} \frac{(1 - m_c)w^*_A}{w^0_A}$$

$$u'_A = (c'_{Ac})^\alpha (c'_{Aw})^{1-\alpha} = (y_c - c^*_{Bc} (1 - m_c))^\alpha (y_w - c^*_{Bw} \frac{(1 - m_c)w^*_A}{w^0_A})^{1-\alpha}$$

$$= (y_c - c^*_{Bc} + m_c c^*_{Bc})^\alpha (y_w - c^*_{Bw} + (1 - \frac{(1 - m_c)w^*_A}{w^0_A}) c^*_{Bw})^{1-\alpha}$$

Undoubtedly, when $m_c = 0$, $u'_A < u^*_A$. In the case of Country A, the compensating

variation allows the consumers to consume $m_c c^*_{Bc}$ more cheese while losing

$(\frac{(1 - m_c)w^*_A}{w^0_A} - 1) c^*_{Bw}$ amount of wine. As such, depending on the preferences of Country

A, if they place a higher weight on cheese, the gain in cheese consumption utility is more

than the loss on wine consumption and they would hence accept the transfer payment

from Country B to not impose tariff.

Take for example, the case where the exogenous variables are defined as follows

$$\alpha = \beta = 0.3$$

$$L_A = L_B = 2000$$

$$a_{Ac} = 2, a_{Aw} = 6, a_{Bc} = 1, a_{Bw} = 2$$

Fitting the equations specified above in Matlab (refer to Appendix for the m-file), and solving for m_c where $u'_A \approx u^*_A$ and $u'_B > u^*_B$, we get $m_c = 0.1535$, which is 15.35% of Country B's national income.

In short, it is hard to conclude whether compensating variation exists or not. Depending on consumer preferences in Country B, Country A, and certain exogenous variables, there might be a m_c such that $u'_A = u^*_A$ and $u'_B > u^*_B$. But if a compensating variation does exist, the global economy is definitely better off with a transfer payment than with the existence of tariffs.

5. Trade specialization and welfare changes

There are a few conclusions that we can arrive at from the above exercise of re-illustrating the Ricardian model and incorporating tariffs into the model setup.

Firstly, the simplistic Ricardian model we have developed highlighted that specializing in comparative advantage is profit motivated on the firm level (Section 4.3) and a country should trade in those goods where they have an advantage as it brings a greater welfare or utility to the global economy increase as compared to autarky. (Section 4.7)

We can see that for the case of China and US, they follow such a result based on their labor distribution and trade patterns.

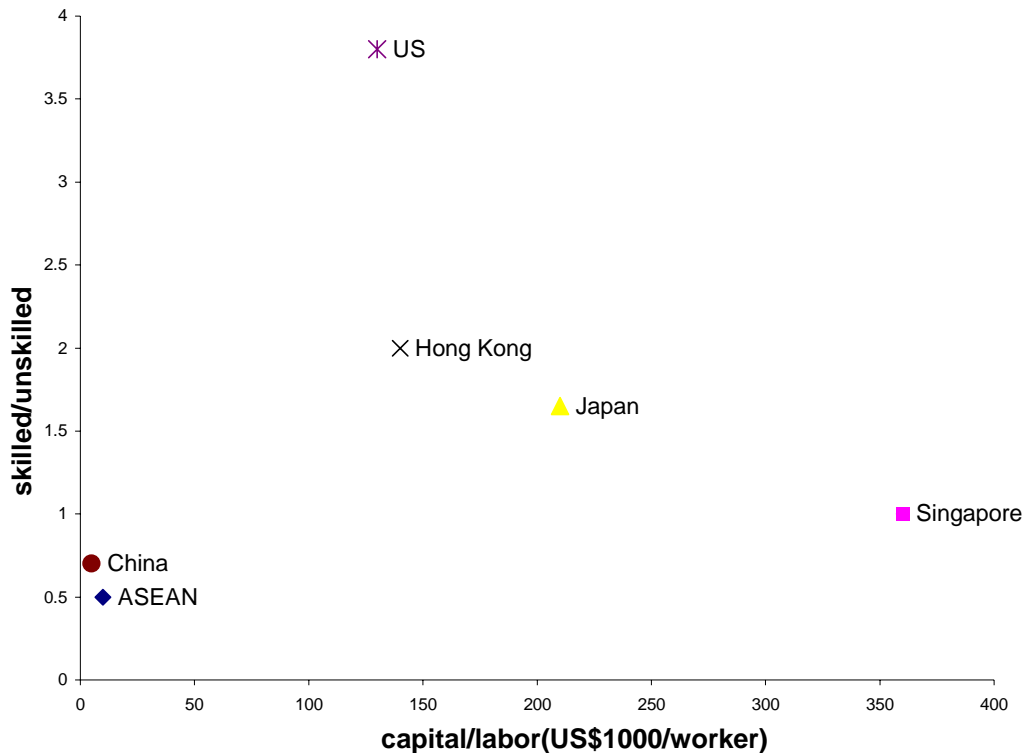


Fig 2: Labor Distribution, Source: US Bureau of Labor Statistics, 2001

China has a low capital to labor ratio as well as a low skill to unskilled worker ratio as compared to China. Naturally, this suggests that China’s labor force is probably better suited and have a comparative advantage in the low-tech, low skilled production goods. While for the US, the higher capital to labor ratio and the higher skilled labor suggests that productivity of the labor is skewed toward high tech goods, or good that require skilled professionals.

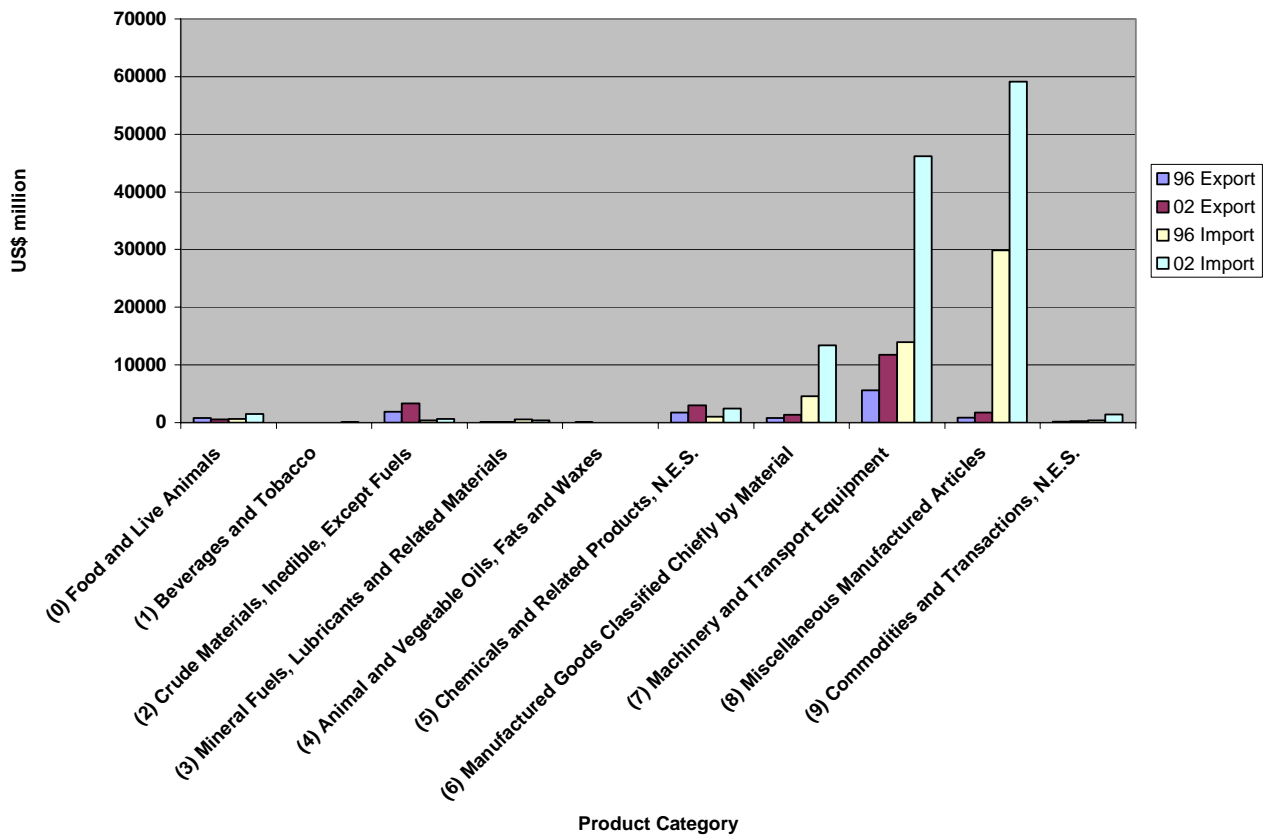


Fig 3: US-China Export Import, Source: US Census Bureau

From 1996 to 2002, US exports to China seem to be increasing in goods that require skilled labor and technical expertise like chemical products and machineries. While for China, the imports for manufactured and assembled low skilled goods including textiles

are constantly increasing from 1996 to 2002. This gives a strong indication that the theory of comparative advantage is at work and could be seen in practical trade patterns.

A closer observation of the break down of exports form China and US into their respective categories reaffirms that initial hypothesis.

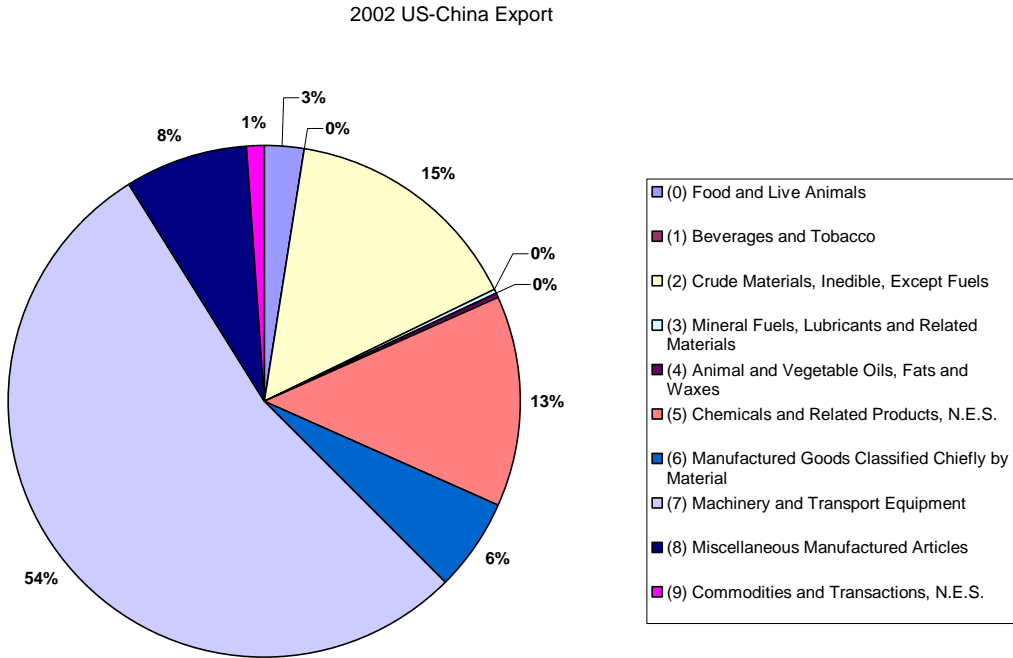


Fig 4: US to China Export composition, Source: US Census Bureau

2002 US-China Import

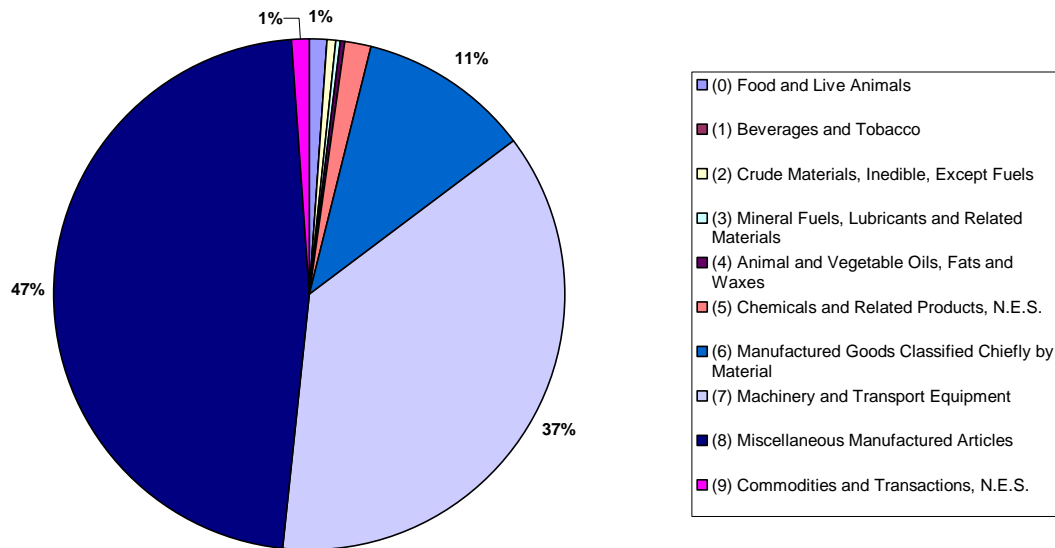


Fig 5: China-US Export composition, Source: US Census Bureau China-US Import Composition

The second conclusion from the model that we have developed points out that the country imposing the tariffs would be enjoying a higher utility at the expense of the other country. (Section 4.7) Given the fact that US and China are major trading partners and China has high tariff barriers with regards to foreign imports, we would assume that based on this model, US is at lower utility level as compared to China. The trade deficit in US has gone up from 10.43 billion dollars in 1990 to 103.115 billion dollars in 2002⁴ which is a clear indication that US is suffering from the high tariff imposed by China.

The model also shows that US would be made better off with a reduction of tariffs while China would be made worse off with a reduction of tariffs. Extending this argument, we

⁴ U.S. Census Bureau, Foreign Trade Division

could see that US has the natural incentives to reduce tariffs dramatically, especially in the areas that they have a comparative advantage in.

Looking at the tariff reduction agreement that China has acceded to after joining WTO (Table 1), the most dramatic decreases in tariffs are the industrial goods, IT goods, and the auto sectors. IT goods had tariffs reduced from 13% to 0% while auto sector goods from 100% to 25%. Since these are also goods that US has a comparative advantage in as we could see from the earlier analysis and Fig 4, with China in the WTO and reducing tariffs, US consumers would all definitely enjoy higher utility in the future.

But why would China join WTO and reduce her tariff rates when this apparently reduces consumer utility? The reduction of tariffs does not come free and China would not agree to it unless she gains from the tariff reduction in some ways like a transfer payment. We have explored such an issue in the development of the model with the concept of compensating variation. (Section 4.8) The utility of US as proven in Section 4.8 would always rise when they give a transfer payment, hence would be willing to give that transfer payment. And if certain exogenous variables and consumer preference coefficients are correct, there exists a transfer payment amount that China is willing to exist to reduce tariff rates.

What then is the carrot that US is dangling in front of China for them to take up WTO? One thing could be that China stands to gain from the acquisition of a permanent Most Favored Nation (MFN) status for permanent normal trade relations with other major

world economic powers such as the United States. According to Director-General of WTO Supachai Panitchpakdi⁵, the MFN status would grow China's market share in the world economy from 3.5 percent to 7 percent within five years! This could indirectly be seen as a form of monetary incentive that is given to China for reduction of tariffs: higher future cash flows from trade due to the MFN status.

From Section 4.7, accepting WTO for China is analogous to accepting a transfer payment and this translates to greater utility for the global economy compared to the state when there are tariffs imposed. Modeling works done by the Australia Chamber of Commerce and Industry found China's national income would increase by 4.6 per cent following its accession to the WTO, while Australia, the United States and the European Union would all see an increase of around 1.8 per cent in their respective national incomes.⁶ The Clinton Administration is also confidently forecasting that the huge U.S. trade deficit with China will improve if Congress accords China permanent normal trade relations (PNTR) in order to accommodate Beijing's membership in the World Trade Organization (WTO). President Clinton claims that the recently signed trade agreement with China "creates a win-win result for both countries" (Clinton 2000, 9). He argues that exports to China "now support hundreds of thousands of American jobs," and that "these figures can grow substantially with the new access to the Chinese market the WTO agreement creates" (Clinton 2000, 10). There is hence a unanimous agreement that China and her major trading partners would gain in the long run from the free trade, with China gaining the most, which is in line with our own model's results.

⁵ World Trade Organization News

⁶ Australian Chamber of Commerce and Industry, China and WTO, Nov 98

6. Conclusion

In conclusion, China's accession to the World Trade Organization is a landmark event, one that has wide ramifications for China, the United States, the WTO, and the world as a whole. It will impel China to be accountable to an internationally agreed set of rules and bind them to wide-ranging economic and systemic changes like tariff reductions. Using a Ricardian model, we explored welfare and product specialization issues with the presence of tariffs so that we could apply the framework to the scenario. But like all models, it suffers from limitations and certain assumptions made are not justified.

The model for example does not take into account frictions in the labor market and the costs due to unemployment and the costs incurred in the transfer of labor between sectors. The fact that there is perfect competition in the market is not a realistic assumption especially for US and China who both work with huge state enterprises and corporate monopolies. The welfare of tariff reduction might also be understated as gains are only seen narrowly by increased good consumption. It also does not take into account the dynamic effects like local State enterprises that restructure and survive will become more efficient and productive, there might be greater access into foreign markets, and terms of trade might be better.

But even though the model is simplistic and does not allow us to calculate the direct impact of tariff reductions in hard numbers, it does offer us a deep insight on the behavior of the countries when dealing with the issue of tariffs in a trading system, and how the

utility of the consumers would be affected by changes in trading systems such as tariff reductions. The model illustrates the fact that certain simple decisions undertaken by China, and US which seem like the most obvious, apparently intuitive thing to do actually follow sound economic theories and make good economic sense.

7. References

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Appendix

Trade with China by 1-digit SITC commodity, in millions of US dollars

1-digit SITC Commodity	96 Export	96 Import	02 Export	02 Import
(0) Food and Live Animals	774.0	653.6	554.23	1,505.33
(1) Beverages and Tobacco	3.3	16.5	6.24	47.55
(2) Crude Materials, Inedible, Except Fuels	1,888.5	376.1	3,336.30	634.17
(3) Mineral Fuels, Lubricants and Related Materials	67.6	513.3	94.33	416.39
(4) Animal and Vegetable Oils, Fats and Waxes	113.6	7.5	28.04	6.25
(5) Chemicals and Related Products, N.E.S.	1,727.3	1,033.5	2,960.03	2,422.74
(6) Manufactured Goods Classified Chiefly by Material	789.6	4,561.9	1,309.73	13,374.24
(7) Machinery and Transport Equipment	5,570.0	13,985.2	11,778.34	46,216.78
(8) Miscellaneous Manufactured Articles	885.9	29,914.9	1,756.32	59,136.17
(9) Commodities and Transactions, N.E.S.	158.0	432.8	229.11	1,408.26
TOTAL	11977.9	51495.3	22,052.68	125,167.89

Source: US Census Bureau, Foreign Trade Division

Timeline of events

- 1978: Deng Xiaoping launches China's Open Door Policy. First reforms take place in agriculture, as individual households are allowed to work land for up to 15 years. Only 12 trading companies are entitled to engage in foreign trade; this number is gradually expanded.
- 1980: China becomes a member of the IMF.
- 1980s: Government allows the collectively-owned so-called township and village enterprises to operate outside the central plan.
- 1986: China applies to join the GATT, the predecessor of the WTO.
- 1989: Work in the GATT Working Group is suspended for two years following Tiananmen.
- 1993: China eliminates its dual exchange rate.
- 1994: China makes first effort to conclude its GATT negotiations.
- 1995: The WTO is established and the Uruguay Round commitments enter into force for WTO Members, widening the scope of GATT rules to include new or increased market access and other commitments in goods, agriculture, textiles, services, and intellectual property rights. The WTO has a binding dispute settlement system for the first time.
- End of 1995: China accepts full convertibility for current account transactions (Article VIII Membership of the IMF).
- 1996: In order to inject new momentum to the negotiations, EU proposes that China may have transition periods to implement certain WTO obligations after WTO accession. This is accepted by WTO members.
- 1997: China agrees to phase out its trading monopoly and to grant full trading rights to all Chinese and foreign individuals and companies within three years of accession. China agrees to fully implement the WTO TRIPS agreement upon accession.
- 1997: China's Party Congress initiates a new phase of the reform process by announcing an overall restructuring of the state enterprise sector, including elements of privatization. (The sector employs well over 120 million people and accounts for 30% of GDP, down from 70% 15 years earlier.)
- 1998: China submits new tariff and services offers.
- 1999: Significant progress made across all fields of the negotiation (agriculture, goods, services, rules), including in bilateral negotiations with the US, EU and other partners.
- November 1999: China concludes bilateral market access agreement with the US. Most market opening commitments will be implemented by the year 2005.
- May 19 2000: China concludes bilateral market access agreement with the EU. Most market opening commitments will be implemented by the year 2005.
- May 24 2000: US House of Representatives support PNTR for China (September 2000: Senate approves bill).
- June 2000: WTO Working Party resumes its work of drafting China's so-called Protocol of accession and Working Party report.
- 2001: WTO Working Party finalizes its work and submits China's Protocol and Working Party report to the WTO General Council.
- Sept 17 2001: China becomes WTO Member.

```

% Matlab compensating variation m-file
% exogenous variables
alpha = 0.3; %consumption preferences
beta = 0.3;
La = 2000; %total labor
Lb = 2000;
Aac = 2; %level of tech
Aaw = 6;
Abc = 1;
Abw = 2;
m=0;
%determines comparative advantage
if Aac/Aaw < Abc/Abw
    disp('A exports wine & imports cheese');
else
    disp('A exports cheese & imports wine');
end
%t*
t = (La*Aaw*alpha-(1-beta)*Lb*Abw)/((1-alpha)*(1-beta)*Lb*Abw)
% endogenous variables
while m <= 1
    %with compensating variation
    Wa0 = Lb*(1-beta)/(alpha*La);
    Wb0 = 1;
    Pw0 = Wa0/Aaw;
    Pc0 = Wb0/Abc;

    Cac_prime = (alpha*(La*Wa0+m*Lb*Wb0))/Pc0;
    Caw_prime = (1-alpha)*(La*Wa0+m*Lb*Wb0)/Pw0;
    Cbc_prime = beta*(1-m)*Lb*Wb0/Pc0;
    Cbw_prime = (1-beta)*(1-m)*Lb*Wb0/Pw0;

    Ua_prime=(Cac_prime^alpha)*(Caw_prime^(1-alpha));
    Ub_prime=(Cbc_prime^beta)*(Cbw_prime^(1-beta));

    %with tariff = t_star
    Wa_star = Aaw/Abw;
    Wb_star = 1;
    Pw_star = Wa_star/Aaw;
    Pc_star = Wb_star/Abc;

    Cac_star = (alpha*(La*Wa_star))/((1+t-alpha*t)*Pc_star);
    Caw_star = (1-alpha)*(La*Wa_star)*(1+t)/((1+t-alpha*t)*Pw_star);
    Cbc_star = beta*Lb*Wb_star/Pc_star;
    Cbw_star = (1-beta)*Lb*Wb_star/Pw_star;

    Ua_star=(Cac_star^alpha)*(Caw_star^(1-alpha));
    Ub_star=(Cbc_star^beta)*(Cbw_star^(1-beta));

    if Ub_prime > Ub_star & Ua_prime >= Ua_star
        break
    else
        m=m+0.0001;
    end
end
end

```


Proof of consumption preferences for Cobb-Douglas preferences

$$\max u(c_c, c_w) = c_c^\alpha c_w^{1-\alpha}$$

$$\text{budget constrain: } p_c c_c + p_w c_w = NI$$

$$\Rightarrow c_w = \frac{NI - p_c c_c}{p_w}$$

$$u(c_c, c_w) = c_c^\alpha \left(\frac{NI - p_c c_c}{p_w} \right)^{1-\alpha}$$

$$\frac{du(c_c, c_w)}{dc_c} = \alpha c_c^{\alpha-1} \left(\frac{NI - p_c c_c}{p_w} \right)^{1-\alpha} + (1-\alpha) \left(\frac{NI - p_c c_c}{p_w} \right)^{-\alpha} \left(-\frac{p_c}{p_w} \right) c_c^\alpha = 0$$

$$\Rightarrow \alpha c_c^{\alpha-1} \left(\frac{NI - p_c c_c}{p_w} \right)^{1-\alpha} = (1-\alpha) \left(\frac{NI - p_c c_c}{p_w} \right)^{-\alpha} \left(\frac{p_c}{p_w} \right) c_c^\alpha$$

$$\Rightarrow \alpha \left(\frac{NI - p_c c_c}{p_w} \right) = (1-\alpha) \left(\frac{p_c}{p_w} \right) c_c$$

$$\Rightarrow \alpha NI - \alpha p_c c_c = p_c c_c - \alpha p_c c_c$$

$$\Rightarrow c_c = \frac{\alpha NI}{p_c}$$