The Welfare Analyses of Bilateral Tariff Increases Under the existence of Asymmetric Trade Costs

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Abstract

In the conclusion of the two-country endogenous trade pattern model of Dornbusch et al. (1977), when two countries are of different technologies and different populations、bilateral tariff increases will cause the price level of the two countries increase and no change to relative wage。Therefore,the welfare of both countries will decrease。 In this paper we show that their proposition doesn't hold if there exist asymmetric trade costs between the two countries。 Bilateral tariff increase will cause the country who assumes more trade cost an increase in its wage from the transformation of trade cost to income。 Now,even the economic scale of the two countries are the same, the country with more population will have an increase in its welfare, and the total welfare of the world will also increase。 Besides,if the two countries are of different economic scale and different trade costs, bilateral tariff increases will cause the world welfare increase from the increase of the welfare of the country with bigger economic scale。 When there exist no trade costs, our model also can fully duplicate the conclusion from the Dornbusch et al. (1977)

Keywords : trade cost, trade pattern, welfare, population size
JEL codes : F15, F42

1 Introduction

The debates of trade policies may be seen as the origin of the nowadays economics. Numerous attempts have been made by scholars to analyze the effects of different trade policies on the economies under various economic model. These policies may include tariff, investment, corporate tax, and trade barriers such as duty, licenses, quotas, local contents, Voluntary Export Constraint, and so on. [1] Trade barriers will cause the additional costs to the international trade if compared with the domestic trade. Beside trade barriers, the transportation costs is also an important source of the trade costs. In this paper, we denote all the cost from international trade other than tariff as the trade costs. Although a large number of studies have been made on the effect of tariff or the effect of trade costs, only a few attempts have so far been made at analyzing the effect of tariff when there exists indispensible trade costs.

On the analyses of trade policies, the economic models can be classified into two kinds of economies, exchange economy and production economy; three types of the goods, importables, exportables, and nontradables; five types of the target country, small open economy, large country, two countries, three countries, and n countries; The setting of exchange economy in the trade policy analyses is overwhelmed by the production economy ever since the late twentith century by the development of modern economic methodology. [2] The models with three countries or more are mainly used to analyze the issues about custom union or FTA. The purpose of this paper is to investigate the classical issue of the welfare effect of bilateral tariff increases if there exists indispensible trade costs. Over the past trade policy literatures, most studies are set in an ad hoc manner that some goods are importables, some goods are exportables, and some goods are nontradables. Their attributes are appointed, not by the competition of international trade. The seminal setting of Dornbusch et al. (1977) enlighten the economists to introduce the comparative advantage into the determination of endogenous trade pattern. By this method, economists can study the effect of trade policy on the income and price with the microfoundation of the change in the trade pattern. In their paper, they

[1] For a comprehensive survey on the issue of trade costs, please refer to the Anderson and van Wincoop (2004).

[2] The classical papers of Bickerdike (1906), Benham (1940), Kennan and Riezman (1988) are all modelled as exchange economies.

first endogenize the nontraded goods by the existence of the iceberg-type transport cost and then discuss the effect of tariff on the trade pattern and the welfares of the two countries. Their conclusions are that unilateral tariff increase will enhance the welfare of home country, but undermine the welfare of foreign country; bilateral tariff increase will cause the price level increase in the two countries without the increase in the relative wage if the two counties are of the equal economic size.

The extensions of the Dornbusch et al. (1977) Ricardian model with a continuum of goods can be classified by their issues. The intertemporal models are mainly for the analyses of the adjustment of gain from trade, trade balance, and quality improvement, such as Taylor (1993)及Taylor (1994). The issues of static models following the Dornbusch et al. (1977) Ricardian model are much more extensive. For example, Dornbusch et al. (1980) and Xu (1993) extend it to incorporate two kinds of factor, labor and capital; Matsuyama (2000) and Stibora and Vaal (2007) discuss the issue of the households with non-homothetic preferences; Kimbrough (1992) extend it to discuss the monetary issue、Cheng et al. (2005) set the nontraded interval as the target of FDI for the multinational firms、Andersen (2005) consider the situation when there exist unemployment。Besides, Sanyal (1983) and Yi (2003) study the issue of vertical specialization in a continuum of goods; Collins (1985)、Appleyard et al. (1989) and Conway et al. (1989) study the issue of technological divide and economic integration among the three countries; Wilson (1980) generalize the model with n countries and 、Eaton and Kortum (2002)、Bernard et al. (2003),and Alvarez and Lucas (2007) extend it to calibrate the data of the OECD countries and US trade partners to investigate the effect of tariff to each countries.

As maintained by Eaton and Kortum (2002), Bernard et al. (2003), and Alvarez and Lucas (2007), "even ideally free trade is not costless trade", International trade not only have to incur more transportation cost, but also encounter the different languages, custom rules, business model, commodity channels, and political regimes. All of these factors will cause the firm engaging in international trade incur more cost than domestic sales. Hence, trade policy analyses should take the trade costs as embedded factors. Dornbusch et al. (1977) didn't discuss the effect of bilateral tariff increase when there exists trade cost. Although Eaton and Kortum (2002), Bernard et al. (2003), and

Alvarez and Lucas (2007) put more emphases on the issue of trade costs, the trade costs in their setting are either combined with tariff, or identical, symmetric between every two countries. This kind of setting will ignore the fact that the cost for home country to trade with foreign country may be different to the cost for the foreign country to trade with home country. For example, Japanese firm always own more efficient international channel from their big "sogo shosha" than other newly industrialized Asian countries. Therefore, the trade costs of Japanese firms to other Asian countries may be lower than the trade costs of the Asian countries to Japan. Under this circumstance, we should reconsider the conclusion from the identical, symmetric setting of trade costs.

The purpose here is to explore what may happen if the trade costs are asymmetric. The results are interesting. When the trade costs are symmetric and the two countries are of the equal economic scale, bilateral tariff increase have no effect on the relative wage and welfare. However, when the trade costs are asymmetric, bilateral tariff increase will improve the welfare of the country with lower trade cost. If this country own more population, this kind of bilateral tariff increase will even increase the world welfare from the less waste of trade cost. If the two countries are of diffenent economic scale, this kind of conclusion still hold if the country with lower trade cost owns big enough population size.

The plan of the paper is as follows. Section 2 extend the Dornbusch et al. (1977) model with existence of asymmetric trade costs and analyze the equilibria condition of the model to find the relationship between the relative wage and trade pattern. Section 3 makes the parameterization for this model, finds the directions of change in trade pattern, and investigates the welfare effect of the bilateral tariff increase using the equations from the changes in the the trade pattern. The properties of these welfare effects are summarized by three propositions. Section 4 makes some concluding remarks.

2 The DFS Model

Following the setting of Dornbusch et al. (1977),we build a 2-country Ricardian model with a continuum of goods indexed in $(0, 1)$。 Each goods $y(i)$ is produced by constant labor input $a(i)$ for each unit of output。 The commodities are indexed so that relative unit labor re-

quirements are ranked in order of diminishing home country comparative advantage。Define $A(i)$ as the relative unit labor input of goods i, we have

$$A\left(i\right) \equiv \frac{a^{*}\left(i\right)}{a\left(i\right)}\ ,\ \text{where} A^{\prime}\left(i\right) < 0\ \ \forall\ i \in (0,1)$$

The asterisk is used to represent the foreign countries.

There exist trade costs take the form of shrinkage as the Samuelson (1954) model, a fraction $g(g^{*})$ of commodity exported from foreign(home) country actually arrives home(foreign) country。Besides, each country may levy tariff on the imported goods。Countries trade with each other based on their comparative advantage of each goods。Hence, some goods become imported goods of the home countries beacause its price is still competitive even foreign producer incurs the tariff and trade cost on its production cost。On the other hand, some goods becom nontraded goods of both countries because neither country's price is competitive in other country. Therefore, we have the following relations

- the goods which home country owns comparative advantage

$$\left(\frac{1}{g^{*}} + t^{*}\right) w \cdot a\left(i\right) < w^{*} \cdot a^{*}\left(i\right)$$

- the goods which foreign country owns comparative advantage

$$\left(\frac{1}{g} + t\right) w^{*} \cdot a^{*}\left(j\right) < w \cdot a\left(j\right)$$

- the goods which neither country owns comparative goods

$$\left(\frac{1}{g^{*}} + t^{*}\right) w \cdot a\left(s\right) > w^{*} a^{*}\left(s\right)$$

$$\left(\frac{1}{g} + t\right) w^{*} \cdot a^{*}\left(s\right) > w \cdot a\left(s\right)$$

Let z^{*} be the left margin of the foreign country's production interval, and z be the right margin of the home country's production interval. Following the assumption of the Dornbusch et al. (1977) model, the commodity market is perfect competition. The goods price in each country will be

$$p(i) = w \cdot a(i)\ ,\ p^{*}(i) = (\frac{1}{g^{*}} + t^{*}) w \cdot a(i)\ ,\ \forall\ i \in\ (0, z^{*}) \qquad (1)$$

$$p(j) = (\frac{1}{g} + t)w^* \cdot a^*(i) \ , \ p^*(i) = w^* \cdot a^*(i) \ , \ \forall \ j \in \ (z, 1) \qquad (2)$$

$$p(j) = w^* \cdot a(s) \ , \ p^*(s) = w^* \cdot a^*(s) \ , \ \forall \ s \in \ (z^*, z) \qquad (3)$$

Since the intervals of the export goods、import goods、and the non-traded goods are determined by the technology、trade cost and tariff of each country, the trade pattern between the two countries is endogenous.

2.1 The Households

The utility level of households depends on their comsumption of the composite goods $\mathbf{C}$, with the following relations

$$u = \ln \mathbf{C}$$

$$\mathbf{C} = \exp \int_0^1 \theta \left(i \right) \ln c \left(i \right) \mathrm{d}i$$

where $\theta(i)$ represent the preference of the household on the goods i and the preferences of the households are identical and homothetic. Besides, $\theta(i)$ satisfies

$$\int_0^1 \theta \left(i \right) \mathrm{d}i = 1$$

,and $\lambda(z)$ and $\lambda(z^*)$ are defined as

$$\lambda \left(z \right) \equiv \int_0^z \theta \left(i \right) \mathrm{d}i$$

$$\lambda^* \left(z^* \right) \equiv \int_{z^*}^1 \theta^* \left(i \right) \mathrm{d}i$$

The households maximize the utility under the constraint of their income $\mathbf{e}$. Beside their wage revenue w, household also receive the tariff revenue rebates ϕ from the government. Hence, we have

$$\mathbf{e} = w + \phi$$

Let $\mathbf{P}$ be the price level. From the expenditure minimization and the utility maximization of the households, we have the demand function and the consumption-based price level as the following

$$c(i) = \frac{\theta(i)\,\mathbf{e}}{p(i)} \tag{4}$$

$$c^*(i) = \frac{\theta(i)\,\mathbf{e}^*}{p^*(i)} \tag{5}$$

$$\mathbf{P} = \Omega \cdot w^{\lambda(z)} \left(\frac{1+g\cdot t}{g} w^*\right)^{1-\lambda(z)} \exp\left\{\int_0^z \theta(i)\ln a(i)\mathrm{d}i + \int_z^1 \theta(i)\ln a^*(i)\mathrm{d}i\right\} \tag{6}$$

$$\mathbf{P}^* = \Omega \cdot \left(\frac{1+g^*\cdot t^*}{g^*} w\right)^{1-\lambda^*(z^*)} (w^*)^{\lambda^*(z^*)} \cdot \exp\left\{\int_0^{z^*} \theta(i)\ln a(i)\,\mathrm{d}i + \int_{z^*}^1 \theta(i)\ln a^*(i)\,\mathrm{d}i\right\} \tag{7}$$

where

$$\Omega \equiv -\exp\left\{\int_0^1 \theta(i)\ln\theta(i)\mathrm{d}i\right\}$$

The revenue of the foreign exporter for each unit of goods j can be represented as

$$cif(j) = \frac{1}{g} w^* \cdot a^*(j) \tag{8}$$

We can derive the tariff revenue of the home country government is

$$\int_z^1 [p(j)\,c(j) - cif(j)\,c(j)]\mathrm{d}j = \frac{g\cdot t}{1+g\cdot t}(1-\lambda(z))\,\mathbf{e}$$

Hence, the income of the home household with the tariff revenue rebate from the government is

$$\mathbf{e} = \frac{1+g\cdot t}{1+g\cdot t\cdot\lambda(z)} w \tag{9}$$

On the other hand, the revenue of the home exporter for each unit of goods i can be represented as

$$cif^{*}(i)=\frac{1}{g^{*}}w\cdot a(i) \tag{10}$$

the tariff revenue of the home country government is

$$\int_{0}^{z^{*}}\left[p^{*}(i)c^{*}(i)-cif^{*}(i)c^{*}(i)\right]\mathrm{d}i=\left(1-\lambda^{*}(z^{*})\right)\frac{g^{*}\cdot t^{*}}{1+g^{*}\cdot t^{*}}\mathbf{e}^{*}$$

Hence, the income of the foreign household with the tariff revenue rebate from the foreign government is

$$\mathbf{e}^{*}=\frac{1+g^{*}\cdot t^{*}}{1+g^{*}\cdot t^{*}\cdot\lambda^{*}(z^{*})}w^{*} \tag{11}$$

2.2 Producer and the labor market equilibrium

The producer supplies the quantities that the home country and foreign country demand. For each unit of foreign consumption, it will ship $1/g^{*}$ unit of output. Hence, when the goods market is in equilibrium, we have the following relationships :

$$y(i)=L\cdot c(i)+L^{*}\frac{1}{g^{*}}c^{*}(i),i\in(0,z^{*}) \tag{12}$$

$$y(s)=L\cdot c(s),y^{*}(s)=L^{*}\cdot c^{*}(s),s\in(z^{*},z) \tag{13}$$

$$y^{*}(j)=L\cdot\frac{1}{g}c(j)+L^{*}\cdot c^{*}(j),j\in(z,1) \tag{14}$$

The producer hire the labor to produce their output. Suppose that the population of the home country is L, and the foreign country is L^{*}. When the labor market is in equilibrium, we have the following relationships :

$$L=\int_{0}^{z^{*}}a(i)\cdot y(i)\mathrm{d}i+\int_{z^{*}}^{z}a(s)y(s)\mathrm{d}s \tag{15}$$

$$L^* = \int_{z^*}^{z} a(i)\, y(i)\, \mathrm{d}i + \int_{z}^{1} a^*(j)\, y^*(j) \mathrm{d}j \tag{16}$$

By the equations of goods price (1)-(3), goods demand (4)-(5), income (9)-(11), goods market equilibrium (12)-(14), and labor market equilibrium (15)-(16), we have the following equilibrium condition :

$$\frac{w}{w^*} = \frac{1-\lambda^*(z^*)}{1-\lambda(z)} \frac{1+g\cdot t\cdot \lambda(z)}{1+g^*\cdot t^*\cdot \lambda^*(z^*)} \frac{L^*}{L} \tag{17}$$

2.3 Trade balance equilibrium

Under the assumption of zero trade deficit between the two countries, the import expenditure and export revenue of each country must be equal. From the relationships between the consumer price (1)-(2) and export price (8)-(10), we know that the import expenditure of the home country is

$$L \int_{z}^{1} \frac{1/g}{1/g+t} p(j)\, c(j)\, \mathrm{d}j = (1-\lambda(z)) \frac{1}{1+g\cdot t} L\cdot \mathbf{e}$$

,and the export revenue of the home country is

$$L^* \int_{0}^{z} \frac{1/g^*}{1/g^*+t^*} p^*(i)\, c^*(i)\, \mathrm{d}i = (1-\lambda^*(z^*)) \frac{1}{1+g^*\cdot t^*} L^*\cdot \mathbf{e}^*$$

Hence, the trade balance equilibrium condition is

$$\frac{w}{w^*} = \frac{1-\lambda^*(z^*)}{1-\lambda(z)} \frac{1+g\cdot t\cdot \lambda(z)}{1+g^*\cdot t^*\cdot \lambda^*(z^*)} \frac{L^*}{L} \tag{18}$$

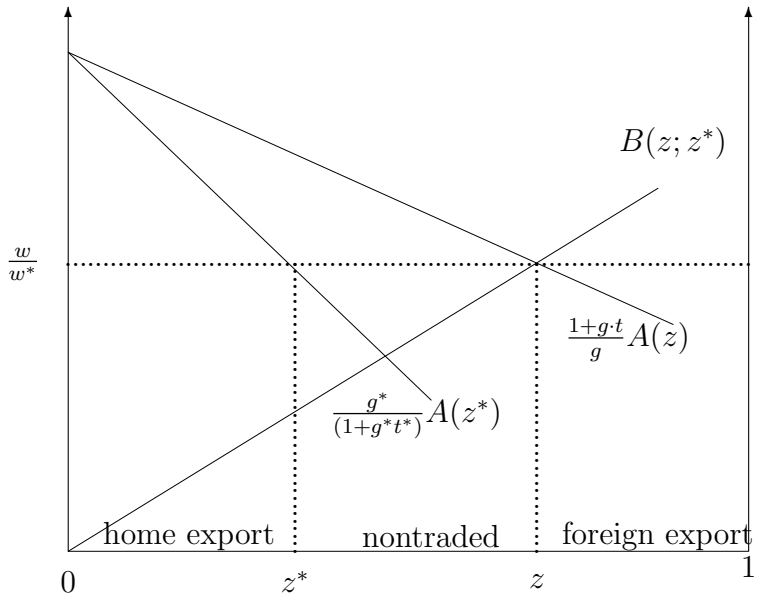
By (17) and (18), we have the same condition for labor market and trade balance equilibrium.

2.4 Endogenous trade pattern

The full equilibrium of the model will at the intersection of the trade balance equilibrim locus and the comparative advantage locus after the markup of trade costs and tariffs. i.e.

$$\frac{g^*}{1+g^*\cdot t^*} A(z^*) = \frac{1+g\cdot t}{g} A(z) = \frac{1-\lambda^*(z^*)}{1-\lambda(z)} \frac{1+g\cdot t\cdot \lambda(z)}{1+g^*\cdot t^*\cdot \lambda^*(z^*)} \frac{L^*}{L}$$

Figure 1: Endogenous trade pattern and the relative wage under the equilibrium



(19)

The relationships between the z, z^* and the relative wage rate can be represented by the Figure.1.

The distinct property of the Dornbusch et al. (1977) model is that its trade pattern is endogenous. The effect of trade policies, such as tariff, trade cost from bureaucratic regulation and transports, will cause the trade pattern change and then change the relative wage, the incomes, the price levels, and the welfare. By using this model, we will discuss the welfare effect of the bilateral tariff increase in the following section.

3 Welfare Analyses of Bilateral Tariff Increases

In order to demonstrate how the bilateral tariff increase change the welfares of the home country and foreign country, we make the parameterization for the Dornbusch et al. (1977) model.

3.1 Parameterization

Suppose that the households have the the preference for each goods, then we have

$$\theta(i) = 1, \forall i \in (0,1) \tag{20}$$

, and by the definition of $\lambda(z)$ and $\lambda^*(z^*)$ we have

$$\lambda(z) = z, \lambda^*(z^*) = 1 - z^*, 1 - \lambda(z) = 1 - z, 1 - \lambda^*(z^*) = z^* \tag{21}$$

Based on the technology of the home country, we normalize the unit labor requirement of each goods to be

$$a(i) = 1\ ,\ a^*(i) = \exp\{\alpha - \beta \cdot i\}\ ,\ \forall\ i \in (0,1) \tag{22}$$

By (21) and (22), we have

$$A(i) = \frac{a^*(i)}{a(i)} = \exp\{\alpha - \beta \cdot i\}$$

$$\frac{w}{w^*} = \frac{z^*}{1-z} \frac{1 + g \cdot t \cdot z}{1 + g^* \cdot t^* \cdot (1 - z^*)} \frac{L^*}{L}$$

By the equation of full equilibrium (19) and the above parameterization, we have

$$z^* = z - \Psi \tag{23}$$

where

$$\Psi \equiv \frac{1}{\beta} \ln \frac{(1 + g \cdot t)(1 + g^* \cdot t^*)}{g \cdot g^*} \tag{24}$$

Besides, we normalize the foreign wage to be $w^* \equiv 1$ and define the share of home population is s, then we have

$$s = \frac{L}{L + L^*}, 1 - s = \frac{L^*}{L + L^*}$$

From the above parameterization and the equilibria conditions of the theoretical model, we can rewrite the equilibria conditions as the following

$$w = \frac{z - \Psi}{1 - z} \frac{1 + g \cdot t \cdot z}{1 + g^* \cdot t^* \cdot (1 - z + \Psi)} \frac{1 - s}{s} \tag{25}$$

$$\mathbf{e} = \frac{1 + g \cdot t}{1 + g \cdot t \cdot z} w \tag{26}$$

$$\mathbf{e}^* = \frac{1 + g^* \cdot t^*}{1 + g^* \cdot t^* (1 - z + \Psi)} \tag{27}$$

$$\mathbf{P} = \Omega \cdot w^z \left(\frac{1 + g \cdot t}{g} \right)^{1-z} \exp \left\{ \alpha (1 - z) - \frac{\beta}{2} \left(1 - z^2 \right) \right\} \tag{28}$$

$$\mathbf{P}^* = \Omega \cdot \left(\frac{1 + g^* \cdot t^*}{g^*} w \right)^{z-\Psi} \exp \left\{ \alpha (1 - z + \Psi) - \frac{\beta}{2} \left(1 - (z - \Psi)^2 \right) \right\} \tag{29}$$

These are the key equations for the following analyses.

3.2 The change of trade pattern under the bilateral tariff increases

By the total derivative of the full equilibrium condition (19) under the parametrization, we have the equations of trade pattern changes under the unilateral tariff increase as the following

$$\frac{\partial z}{\partial t} = \frac{1}{\Phi}\left[\frac{g}{1+g\cdot t} - \frac{g\cdot z}{1+g\cdot t\cdot z} + \frac{1}{\beta}\frac{g}{1+g\cdot t}\left(\frac{1}{z-\Psi} + \frac{g^*\cdot t^*}{1+g^*\cdot t^*\cdot(1-z+\Psi)}\right)\right] > 0 \tag{30}$$

$$\frac{\partial z}{\partial t^*} = \frac{1}{\Phi}\left[\frac{g^*(1-z+\Psi)}{1+g^*(1-z+\Psi)} + \frac{1}{\beta}\frac{g^*}{1+g^*\cdot t^*}\left(\frac{1}{z-\Psi} + \frac{g^*\cdot t^*}{1+g^*\cdot t^*(1-z+\Psi)}\right)\right] > 0 \tag{31}$$

$$\frac{\partial z^*}{\partial t} = \frac{-1}{\Phi}\left[\frac{g\cdot z}{1+g\cdot t\cdot z} + \frac{1}{\beta}\frac{g}{1+g\cdot t}\left(\frac{1}{1-z} + \frac{g\cdot t}{1+g\cdot t\cdot z}\right)\right] < 0 \tag{32}$$

$$\frac{\partial z^*}{\partial t^*} = \frac{-1}{\Phi}\left[\frac{g^*(z-\Psi)}{1+g^*\cdot t^*(1-z+\Psi)} + \frac{1}{\beta}\frac{g^*}{1+g^*\cdot t^*}\left(\frac{1}{1-z} + \frac{g\cdot t}{1+g\cdot t\cdot z}\right)\right] < 0 \tag{33}$$

where

$$\Phi \equiv \beta + \frac{1}{z-\Psi} + \frac{1}{1-z} + \frac{g\cdot t}{1+g\cdot t\cdot z} + \frac{g^*\cdot t^*}{1+g^*\cdot t^*\cdot(1-z+\Psi)} > 0 \tag{34}$$

On the other hand, the trade pattern changes under the bilateral tariff increases are

$$\begin{aligned}\left.\frac{\partial z}{\partial t}\right|_{\mathrm{d}t=\mathrm{d}t^*} =& \frac{1}{\Phi}\left[\frac{g}{1+g\cdot t} - \frac{g\cdot z}{1+g\cdot t\cdot z} + \frac{1}{\beta}\frac{g}{1+g\cdot t}\left(\frac{1}{z-\Psi} + \frac{g^*\cdot t^*}{1+g^*\cdot t^*(1-z+\Psi)}\right)\right.\\ &\left. + \frac{g^*\cdot(1-z+\Psi)}{1+g^*\cdot t^*\cdot(1-z+\Psi)} + \frac{1}{\beta}\frac{g^*}{1+g^*\cdot t^*}\left(\frac{1}{z-\Psi} + \frac{g^*\cdot t^*}{1+g^*\cdot t^*\cdot(1-z+\Psi)}\right)\right] > 0\end{aligned} \tag{35}$$

$$\left.\frac{\partial z^*}{\partial t}\right|_{\mathrm{d}t=\mathrm{d}t^*} = \frac{-1}{\Phi}\left[\frac{g\cdot z}{1+g\cdot t\cdot z}+\frac{g^*\left(z-\Psi\right)}{1+g^*\cdot t^*\left(1-z+\Psi\right)}\right.$$
$$\left.+\frac{1}{\beta}\left(\frac{g}{1+g\cdot t}+\frac{g^*}{1+g^*\cdot t^*}\right)\left(\frac{1}{1-z}+\frac{g\cdot t}{1+g\cdot t\cdot z}\right)\right]<0 \tag{36}$$

To sum up the properties of the trade pattern change under the tariff increases of this model, we have the following Proposition 1.

Proposition 1. *The tariff increases will enlarge the production interval for each country under the setting of two-country Ricardian model with a continuum of goods, no matter this kind of tariff increase is unilateral or bilateral. This result comes from the fact that tariff increase will cause more goods become nontraded goods.*

Proof. By the equations of (30)-(36), we know that tariff increases will cause the right margin (z) of home country production interval move to right and the left margin (z^*) of the foreign country production move to left. The nontraded goods interval (z^*, z) is enlarged. Hence,the production intervals of each country become larger. □

3.3 Welfare analyses

The analyses of Dornbusch et al. (1977) under the assumption of zero trade cost propose that "*if countries are of equal size as measured by the share in world income, such a uniform tariff increase has zero effect on relative wages, but of course reduces well-being in both places*". We are much interested in whether this kind of conclusion still hold if there exists trade costs.

Let z_0, z_0^*, Ψ_0, Φ_0 be the values of the z, z^*, Ψ, and Φ when $t = t^* = 0$. By the (35)-(36), when $t = t^* = 0$ initially, we have the following equations

$$\left.\frac{\partial z}{\partial t}\right|_{\mathrm{d}t=\mathrm{d}t^*,t=t^*=0} = \frac{1}{\Phi_0}\left[g\left(1-z_0\right)+\frac{1}{\beta}g\left(\frac{1}{z_0-\Psi_0}\right)+g^*\left(1-z_0+\Psi_0\right)+\frac{1}{\beta}g^*\left(\frac{1}{z_0-\Psi_0}\right)\right]>0 \tag{37}$$

$$\left.\frac{\partial z^*}{\partial t}\right|_{\mathrm{d}t=\mathrm{d}t^*,t=t^*=0} = \frac{-1}{\Phi_0}\left[g\cdot z_0+g^*\cdot\left(z_0-\Psi_0\right)+\frac{1}{\beta}\left(g+g^*\right)\frac{1}{1-z_0}\right]<0$$

(38)

Take the above equations (37)-(38) to the derivative of relative wage (25), we have

$$\left.\frac{\partial \ln w}{\partial t}\right|_{\mathrm{d}t=\mathrm{d}t^*,t=t^*=0} = \frac{1}{\Phi_0}\left[g\left(\beta\cdot z_0+\frac{1}{1-z_0}\right)-g^*\left(\beta\left(1-z_0+\Psi_0\right)+\frac{1}{z_0-\Psi_0}\right)\right] \tag{39}$$

It is straightforward that when trade costs are zero, $g = g^* = 0$, we have

$$\left.\frac{\partial \ln w}{\partial t}\right|_{\mathrm{d}t=\mathrm{d}t^*,t=t^*=0,g=g^*=0} = 0 \tag{40}$$

i.e. the proposition of Dornbusch et al. (1977) holds when trade costs are zero. However, we can not find the direction of (39) directly if we have no further information. Once again we quote the words from Dornbusch et al. (1977), "countries are of equal size as measured by the share in world income" means that $s\cdot\mathbf{e} = (1-s)\cdot\mathbf{e}^*$. Take it into the (25), we have

$$s\cdot\mathbf{e} = s^*\cdot\mathbf{e}^* \Rightarrow 1-z_0 = z_0-\Psi_0, z_0 = 1-z_0+\Psi_0 \tag{41}$$

By (39) and (41), we obtain

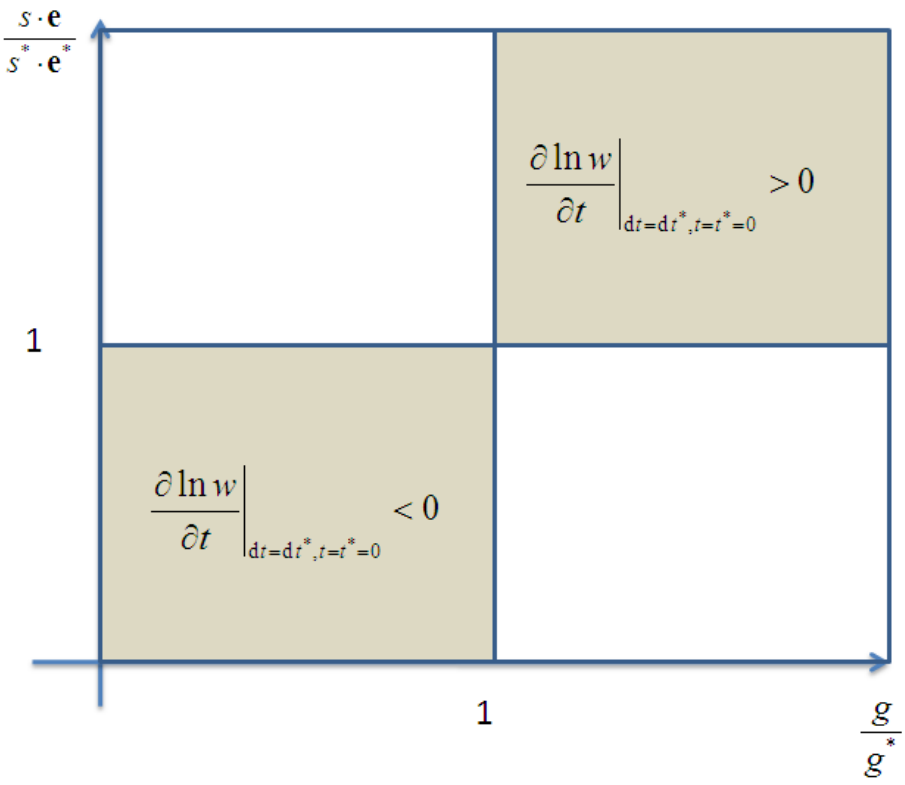
$$\left.\frac{\partial \ln w}{\partial t}\right|_{\mathrm{d}t=\mathrm{d}t^*,t=t^*=0} = \frac{g-g^*}{\Phi_0}\left[\beta\cdot z_0+\frac{1}{1-z_0}\right] \tag{42}$$

To sum up the above equations, we have the following Proposition 2.

Proposition 2. *The tariff increases will have different effect on the relative wage of the two countries under the setting of two-country Ricardian model with a continuum of goods. When there exists no trade costs, the relative wage will not change. When there exists asymmetric trade costs between the two countries, the relative wage will change. The relative wage of the country with lower trade cost will increases.*

Proof. By equations (40) and (42), we can find that the direction of relative wage change is decided by the relative value trade costs. When there exists no trade costs, as the (40), there is no change to

Figure 2: The area where bilateral tariff increases have oppositive effect on the



the relative wage. When there exists asymmetric trade costs, $g \neq g^*$, we have

$$\frac{1}{g} < \frac{1}{g^*} \Leftrightarrow g > g^* \Rightarrow \frac{\partial \ln w}{\partial t}\Big|_{dt=dt^*,t=t^*=0} > 0$$

Since $\frac{1}{g} < \frac{1}{g^*}$ implies the cost of trade to home country is lower, the above equation implies that The relative wage of the country with lower trade cost will increases. □

This kind of relationship can be demonstrated by the Figure 2

As far as the welfare change is concerned, we can find that under the optimal decision of the households, the utility level will be decided

by the income and price level.

$$u = \ln \mathbf{e} - \ln \mathbf{P} \ , \ u^* = \ln \mathbf{e}^* - \ln \mathbf{P}^* \tag{43}$$

Hence, we need the relationships of the price level and income with respect to the tariff increases. Take equations (37) and (38) to the derivatives of equations (26)- (29), we obtain

$$\left.\frac{\partial \ln \mathbf{P}}{\partial t}\right|_{\mathrm{d}t=\mathrm{d}t^*,t=t^*=0} = g\left(1-z_0\right) + z_0 \left.\frac{\partial \ln w}{\partial t}\right|_{\mathrm{d}t=\mathrm{d}t^*,t=t^*=0} \tag{44}$$

$$\left.\frac{\partial \ln \mathbf{P}^*}{\partial t}\right|_{\mathrm{d}t=\mathrm{d}t^*,t=t^*=0} = \left(z_0-\Psi_0\right)\left(g^* + \left.\frac{\partial \ln w}{\partial t}\right|_{\mathrm{d}t=\mathrm{d}t^*,t=t^*=0}\right) \tag{45}$$

$$\left.\frac{\partial \ln \mathbf{e}}{\partial t}\right|_{\mathrm{d}t=\mathrm{d}t^*,t=t^*=0} = g\left(1-z_0\right) + \left.\frac{\partial \ln w}{\partial t}\right|_{\mathrm{d}t=\mathrm{d}t^*,t=t^*=0} \tag{46}$$

$$\left.\frac{\partial \ln \mathbf{e}^*}{\partial t}\right|_{\mathrm{d}t=\mathrm{d}t^*,t=t^*=0} = g^*\left(z_0-\Psi_0\right) \tag{47}$$

Take the equations (44)-(47) into the equation (43), we obtain

$$\left.\frac{\partial u}{\partial t}\right|_{\mathrm{d}t=\mathrm{d}t^*,t=t^*=0} = \left(1-z_0\right) \left.\frac{\partial \ln w}{\partial t}\right|_{\mathrm{d}t=\mathrm{d}t^*,t=t^*=0} \tag{48}$$

$$\left.\frac{\partial u^*}{\partial t}\right|_{\mathrm{d}t=\mathrm{d}t^*,t=t^*=0} = -\left(z_0-\Psi_0\right) \left.\frac{\partial \ln w}{\partial t}\right|_{\mathrm{d}t=\mathrm{d}t^*,t=t^*=0} \tag{49}$$

Since the world welfare is the summation of the welfare from the two countries, we can find that the world welfare change of the bilateral tariff increases is

$$\left.\frac{\partial\left(L\cdot u + L^*\cdot u^*\right)}{\partial t}\right|_{\mathrm{d}t=\mathrm{d}t^*,t=t^*=0} = \left(L+L^*\right)\left[s\left(1-z_0\right)-\left(1-s\right)\left(z_0-\Psi_0\right)\right] \left.\frac{\partial \ln w}{\partial t}\right|_{\mathrm{d}t=\mathrm{d}t^*,t=t^*=0} \tag{50}$$

Once again, we use the equations from "countries are of equal size as measured by the share in world income". The (50) will be positive if $s > 1/2$.

To sum up the above equations, we obtain the following Proposition 3.

Proposition 3. *The bilateral tariff increases always cause some countries become worse under the setting of two-country Ricardian model with a continuum of goods. However, it might cause the world welfare increase when there exists asymmetric trade costs between the two countries. If one of the two countries has more population and lower cost of import, then the world welfare may increase from the welfare increase of that country. If the two countries are of equal economic size and population size, then there will be no welfare change to the world.*

Proof. By the equations (42) and (50), we can show that when home country has lower cost of import ($1/g < 1/g^*$) and more population $s > 1/2$, then the direction of (42) and (50) will be both positive. Hence, the world welfare will increase. □

From the Proposition 3, we show that the proposition of Dornbusch et al. (1977) that world welfare will will become worse should be confined to the situation that when there are no trade costs. When there exists asymmetric trade costs, their proposition will hold only if the two countries are both of equal size in economic scale and population scale. When there exists asymmetric trade costs and the two countries are of different population size, the world welfare will change by the bilateral tariff increase even the two countries are of the same economic size.

In the general situation, when the two countries are of different economic scale and differnet population size, we can make further analyses about the world welfare change. By the equations (39) and (50), we still can find two kinds of situation when the bilateral tariff increases will cause the world welfare increases. They are

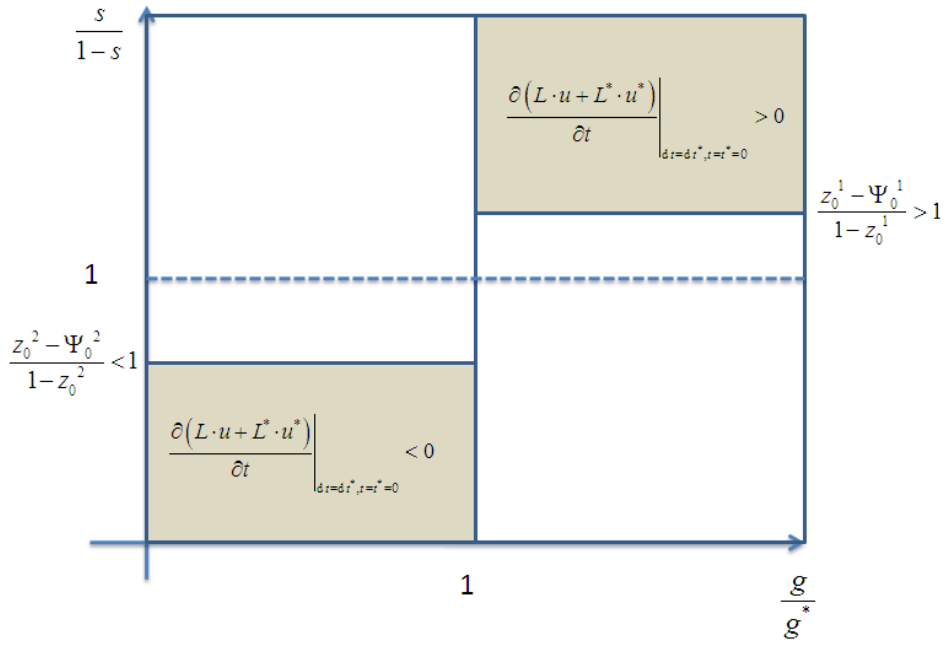
- Situation 1 When home country have lower cost of import ($1/g < 1/g^*$), if home country is also bigger in economic scale and population size and satisfies the following condition,

  $$\frac{s}{1-s} > \frac{z_0 - \Psi_0}{1 - z_0} > 1$$

  then the world welfare will increase.

- Situation 2 When foreign country have lower cost of import ($1/g^* < 1/g$), if home country is also bigger in economic scale

Figure 3: The area where bilateral tariff increases have cause the world welfare increase



and population size and satisfies the following condition,

$$\frac{s}{1-s} < \frac{z_0 - \Psi_0}{1 - z_0} < 1$$

then the world welfare will increase.

From the above analyses, we can find that the world welfare might increase when one of the two countries is bigger in economic scale and population size. Besides, even the two countries are of equal economic scale, the world welfare might still increase if the country with lower trade cost is bigger in population size. This kind of relationship can be demonstrated by the Figure 3

4 Conclusion

In this paper, the analyses of welfare effect of bilateral tariff increases for the two countries based on the extension of the Dornbusch et al.

(1977) Ricardian model with a continuum of goods is proposed. In comparison with most literatures about the welfare effect of tariff, world welfare may not be deteriorated if one of the two countries own lower trade costs and bigger population size. I confined the conclusion of Dornbusch et al. (1977) that bilateral tariff increase have no effect on the relative wage and will only cause the welfare of the two countries become worse to the situation that the two countries are of the equal economic size, equal population size, and symmetric trade costs. If one of these three conditions don't hold, the conclusion will be differnt from theirs.

It should be concluded, from what has been analyzed in the above sections, that asymmetric trade costs will alter the conclusion of the traditional economic literatures about the tariff, and the key factor under this fact is the relative population size of the two countries. Besides, the technology level of the two countries is also an important factor for this conclusion since it will affect the relative economic size of the two countries. An important implication of this paper is that it reminds the policy maker should apply the policy which pay more attetion to lower their trade costs, not just argue the tariff rate the foreign country levies on the home country.

Finally, the asymmetric trade costs approach in this paper is a two-country version, it may be difficult to set in the model with n countries since there will be to many ad hoc parameters in it. It may be deriable to set a more compact model to analyze the trade policies with n countries in the future studies.

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