

ENDOGENOUS TRADE POLICIES IN A DEVELOPING ECONOMY

By

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Abstract

Consider a small developing economy with a manufacturing sector opened to international trade, and an agricultural sector having limited, not to say any, access to world markets. We modify the Grossman and Helpman's *influence-driven* model of trade policy formation to allow for an endogenously determined wage rate in a three-sector economy where the manufacturing sector can lobby policy makers for favorable policies. Beside protectionist policies, namely an import tariff or an export subsidy, we show that the owners of the specific factor in agriculture - a non-lobby group - have to bear a consumption tax imposed on their products. This would further strengthen the trade protectionist measure, and imply possibly undesirable general equilibrium repercussions: there will be a reallocation of labor to the manufacturing sector which enjoys an output expansion, an output contraction in the agricultural sector, and a lower workers' 'real' income.

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1. INTRODUCTION

Trade protectionism among nations is as old as the world itself, although gains from free trade have theoretically been established a long time ago. Under the “new political economy,” trade protection becomes endogenous in the sense that it results from motives lying outside the realm of pure economic efficiency. Countries distort trade flows with policies that affect the distribution of income to achieve political goals. These distorting trade policies could be explained through the political-support function in the analysis of Hillman (1982), Long and Vousden (1991); the electoral competition approach of Brock and Magee (1978); or the more recent influence-buying approach in the influential work of Grossman and Helpman (1994, 1995). Trade protection arises from lobbying activities, which are characterized as rent-seeking. Lobbying activities are unproductive because they transfer income to those who lobby without creating valuable output for the rest of the economy. Beside the cost involved in lobbying, there are also welfare loss incurred by consumers who are forced to forgo cheaper imports and who must pay higher prices for goods produced in the protected sectors.

Protectionism inherent in the trading flows between rich and poor nations is an increasing concern in a world in which poverty in developing countries has become alarming. Yet poor nations – often producers of foods and agricultural products – have little, if any at all, access to these markets in industrialized nations because these countries systematically use subsidies to skew the benefits of agricultural trade in their favor. According to Watkins and von Braun (2003), high tariffs and other trade barriers are used by the industrialized nations to keep out imports. The U.S and the E.U, spend 300 billion US dollars in support of their agriculture, a sector that accounts for less than 2% of national income, while in developing countries, more than 70% of the population lives

and works in rural areas, producing food and agricultural products that account on average for 35 % of the national gross domestic product. The tariffs imposed by the U.S. and the E.U on agricultural goods are four to five times of those applied to manufactured goods. The tariff that the U.S. imposes on ground nuts is in excess of 100% of the imported price. In the E.U., the tariffs on dairy products, and worse, on beef, sugar..., are equally prohibitive. This would leave billions of people in the world with no market to export their agricultural products. Most of these goods are not traded, because of the protectionist measures adopted by industrialized countries to protect their agricultural producers. Ironically, the response of poor nations to Western protectionism is also to adopt protectionist measures, but in the manufacturing sector – deemed to consist of all infant industries – which need to be kept alive in a worldwide competition context.

In this paper, we attempt to analyze the consequences of influence buying in a small developing country that is opened for international trade. There are three production sectors: a sector producing a freely traded good, a sector producing a traded manufacturing good, and a sector producing a non-traded good (the agricultural sector). Following Samuelson (1971) and Jones (1971), we assume that the production technology in these sectors requires the use of labor and a specific factor. The production structure in our model is the same as that of Corden and Neary (1982), who drew on Jones, *op cit.*, in formulating a model for analyzing the problem of booming and declining sectors in a small open economy. Most of comparative static general-equilibrium results used in our paper can be found in Corden and Neary. However, in our paper, we offer an explanation for the endogenous determination of policies driven by lobbying activities.

Among the three production sectors, the first sector produces a traded good, which is freely traded and serves as the numéraire. The second is the manufacturing sector, which produces a traded good, and the third sector, the agriculture sector, produces a non-traded good. The production technology in these sectors requires the use of labor and a specific factor. Owners of the specific factor in the production of the traded good is highly

concentrated, which makes it easier for them to get organized³ as a special interest group to lobby policy makers for the adoption of favorable trade policies.⁴ In contrast, small farmers in the non-traded agricultural sector are widely dispersed, and thus they could not organize themselves as an interest group to influence policy makers. Workers could not exert such influence, either, since there is effectively no institution like labor unions that might play a role in setting wages. In exchange for their labor, workers receive a competitive wage determined by market conditions. We would like to point out at this point that the wage rate is endogenously determined in our analysis, not fixed as in the framework of Grossman and Helpman. Trade policies, therefore, have an impact on the supply side through intersectoral allocation, in contrast with the analysis of these researchers, who considered only the repercussions on the demand side. Under some plausible conditions, we are able to show that lobbying activities carried out by the owners of the specific factor in the manufacturing sector secure a protectionist trade policy through either an import tariff or an export subsidy for this sector. In contrast with the result obtained by Grossman and Helpman, which asserts that the non-lobbying group should be subsidized, we show that this group – namely the owners of the specific factor in agriculture in our model – will have to bear a tax. Thus, the owners of the specific factor in the manufacturing sector also benefit indirectly from the consumption tax imposed on the consumption of the non-traded good, namely the good produced by the agricultural sector. Labor moves to the manufacturing sector, and at the new equilibrium there will be an increase in the wage rate, an output expansion in the manufacturing sector, an output contraction in the agricultural sector. The rent made by owners of specific factor in the manufacturing sector will rise after the new equilibrium has been established, while the rent in the numéraire sector will have fallen. As to the rent to the owners of the specific factor in the agricultural sector, it may rise or fall, depending on the parameters of the model.

³ Mitra (1999) went a step further in considering how lobby groups have been organized prior to their activities.

⁴ Lobbying activities are akin to a form of corruption in developing countries, with the presumption that in these countries bribery is a sort of crime without effective sanction. However, a discussion of corruption would involve the morality associated with illegal acts and the need to set up effective penalties against these acts. Since we disregard these aspects, it is more appropriate to consider lobbying here as a legal and legitimate practice.

The paper is organized as follows. In Section 2, we present our model – a three-stage game – which is a modified version of the model of Grossman and Helpman, and in which we allow for labor mobility across the three sectors of production. Within a general equilibrium setting, we solve our problem of endogenous policy formation. In Section 3, we present the third stage of this game and elicit the impact of policy changes on the pattern of resource allocation. In Section 4, we focus on the endogenous determination of trade policy in the second and first stages of our game. Finally, in Section 5, we summarize our results and extend our discussion to the question of political stability that developing countries should face in choosing trade policy.

2. THE MODEL

Consider a small open economy with three goods produced from labor and capital. The three goods are labeled good 1, good 2, and good 3. Good 1 and good 2 are assumed to be traded on world markets, while good 3 is non-traded. For a developing country, good 3 may either be non exportable local service and/or foods and agricultural products, which are heavily protected by their industrialized trading partners. Until these days, repeated calls for easing this kind of protection in order to alleviate poverty in developing rural economies receive, to say the least, fairly weak echoes. Good 1 is freely traded, and is chosen as the numéraire. Let p_1^0 and p_2^0 denote the world prices of goods 1 and 2. Let p_i and q_i denote, respectively, the domestic prices of good i faced by its producers and consumers. Since good 1 serves as the numéraire and is freely trade, we have $p_1 = q_1 = p_1^0 = 1$. For good 2, the government can impose an import tariff (or an export subsidy) $\tau_2 \geq 0$. In this case, $p_2 = q_2 = p_2^0 + \tau_2$. For good 3, the non-traded good, we shall assume that a consumption tax (or subsidy), $\tau_3 \geq 0$ (if $\tau_3 \leq 0$), is imposed on its consumers. In this case, $q_3 = p_3 + \tau_3$. A combination (τ_2, τ_3) will be referred to as a policy.

On the production side, labor is assumed to be homogenous and perfectly mobile. Its fixed supply is denoted by \bar{L} . Capital is sector-specific, and the capital stock in sector i is denoted by $\bar{K}_i, i = 1, 2, 3$. The output of good i is given by $Y_i = F_i(L_i, \bar{K}_i)$, where L_i is the labor input and F_i is a standard neoclassical production function that exhibits constant returns to scale. The rent accrued to the factor-specific capital is then given by $p_i Y_i - \omega L_i$, where ω is the prevailing wage rate. Sector i solves the following rent-maximization problem:

$$(1) \quad \max_{L_i} [p_i F_i(L_i, \bar{K}_i) - \omega L_i] = \Pi_i(p_i, \omega), \quad (i = 1, 2, 3).$$

We shall let $L_i(p_i, \omega)$ denote the labor input used by sector i , which is the solution of the preceding rent maximization problem and $Y_i(p_i, \omega) = F_i(L_i(p_i, \omega), \bar{K}_i)$ denote this sector's output.

Let N be the size of the population of the small open economy. We shall assume that N is a continuum of measure 1. Each individual in the population is assumed to own only one type of input. We refer to group i as the group of individuals who own the specific factor \bar{k}_i . For each $i = 1, 2, 3$, let γ_i denote the size of group i relative to the total population. The workers – as a group – will be referred to as group 4. If $\bar{L} < \gamma_4$, then $\gamma_4 - \bar{L}$ represents the number of individuals who are either unemployed and/or working in the informal sector. Even being identified as a common feature in a developing economy, this problem, however, is not the subject of our analysis. Thus we assume that $\bar{L} = \gamma_4$. Thus groups 1, 2, and 3 obtain their incomes through the ownership of sector-specific capital, while group 4 obtains its income by selling its labor. We expect that γ_4 is large relative to $\gamma_i, i = 1, 2, 3$.

A group, such as the owners of a specific input, who see their income tied to the price of the price of output that this specific input helps to produce, have the incentive to lobby policy makers for policies that enhance their income. In many developing economies, the owners of the specific input used in infant manufacturing sectors often become organized

as a special-interest group to exert such lobbying pressures on the government. This paper will concentrate on this problem, with group 2 as the focus of our attention. In the model we formulate, the individuals who constitute group 2 organize themselves and offer political contributions to the government to buy influence. In this *influence-driven* approach, the political contributions serve to influence the policies implemented by the government.

We suppose that individual preferences are identical and represented by the following quasi-linear utility function: $(x_1, x_2, x_3) \rightarrow x_1 + \sum_{i=2}^3 u_i(x_i)$, where x_i is the consumption of good i and u_i is the sub-utility function associated with the consumption of good $i, i = 2, 3$. We assume that u_i is continuously differentiable, strictly increasing, and strictly concave. An individual with an income m at his disposal solves the following utility maximization problem:

$$(2) \quad \max_{(x_2, x_3)} \left[m - \sum_{i=2}^3 q_i x_i + \sum_{i=2}^3 u_i(x_i) \right] = v(q_1, q_2, m)$$

subject to $m - \sum_{i=2}^3 q_i x_i \geq 0$.

Assuming that the above problem has an interior solution, the following first-order condition characterizes the demand for good $i, i = 2, 3$:

$$(3) \quad u_i'(x_i) - q_i = 0.$$

Letting $x_i(q_i)$ be the value of x_i that solves (2). As defined, $x_i(q_i)$ is the individual's demand for good $i, i = 2, 3$, as a function of its consumer price. The indirect utility function of an individual is then given by

$$(3) \quad v(q_1, q_2, m) = m + s(q_1, q_2),$$

where

$$(3) \quad s(q_2, q_3) = \sum_{i=2}^3 [u_i(x_i(q_i)) - q_i x_i(q_i)]$$

is the consumer surplus enjoyed by this individual.

The game of endogenous policy formation has three stages and its extensive form is as follows.

In the first stage, group 2 lobbies the government by communicating to the policy makers a contingent payment schedule $C_2 : (\tau_2, \tau_3) \rightarrow C_2(\tau_2, \tau_3)$, where $C_2(\tau_2, \tau_3)$ represents the payment that it is willing to make to the government if the policy (τ_2, τ_3) is implemented. The payment $C_2(\tau_2, \tau_3)$ – also called the political contribution in the literature – is expressed in terms of the numéraire, and is valued by policy makers because it can be used as a political support in financing future election or simply put away for personal use.

In the second stage of the game, the policy makers take as given the contingent payment schedule C_2 and implement a policy according to some criterion which depends on the payment as well as on some measure of social welfare. We would like to point out at this point that the game we formulate is that of a principal-agent problem – with group 2 as the principal and the policy makers as the agent – because we assume that neither group 3 nor group 4 is organized as a special-interest group. Indeed, if workers are represented by a strong labor union, and/or if owners of the specific factor used in the food and agricultural production organize themselves as a special-interest group, then all these groups will compete in lobbying the policy makers. In this case, the game is one of many principals against a common agency,⁵ which could be analyzed with the help of the theoretical machinery developed by Bernheim and Whinston, *op. cit.*

In the third stage of the game, the producers take as given the policy implemented by the policy makers in the second stage and carry out their production plans to maximize profit. As for consumers, they make their consumption decisions and these decisions depend on their income as well as the prices they face. Group 2 will then make the contingent payment it promised the government in the first stage.

⁵ We have undertaken this task in our mimeo “*Endogenous Trade Policies with General Equilibrium Repercussions*,” 1998.

Suppose that (τ_2, τ_3) is the policy implemented by the policy makers in the second stage. The general equilibrium of the small open economy is characterized by the following market-clearing conditions:

$$(4) \quad L_1(1, \omega) + L_2(p_2^0 + \tau_2, \omega) + L_3(p_3, \omega) = \gamma_4,$$

$$(5) \quad x_3(p_3 + \tau_3) = Y_3(p_3, \omega).$$

Together, (4) and (5) constitute a system of two equations in the two unknowns p_3 and ω . We shall denote by $p_3(\tau_2, \tau_3)$ and $\omega(\tau_2, \tau_3)$ the equilibrium price of the non-traded good and the equilibrium wage rate that are induced by the policy (τ_2, τ_3) .

The net tax revenue collected under the policy (τ_2, τ_3) is

$$(6) \quad T(\tau_2, \tau_3) = \tau_2[x_2(p_2^0 + \tau_2) - Y_2(p_2^0 + \tau_2, \omega(\tau_2, \tau_3))] + \tau_3 x_3(p_3(\tau_2, \tau_3) + \tau_3).$$

We shall assume that the net tax revenue collected by the government is redistributed equally to all the individuals in the economy. This assumption ensures that the public budget is always balanced.

If (τ_2, τ_3) is the policy implemented by the policy makers, then the payoff of group 1 is given by:

$$(7) \quad W_1(\tau_2, \tau_3) = \Pi_1(1, \omega(\tau_2, \tau_3)) + \gamma_1 [T(\tau_2, \tau_3) + s(p_2^0 + \tau_2, p_3(\tau_2, \tau_3) + \tau_3)]$$

The gross payoff of group 2 – before the political contributions are made – is given by

$$(8) \quad W_2(\tau_2, \tau_3) = \Pi_2(p_2^0 + \tau_2, \omega(\tau_2, \tau_3)) + \gamma_2 [T(\tau_2, \tau_3) + s(p_2^0 + \tau_2, p_3(\tau_2, \tau_3) + \tau_3)]$$

and its net payoff by $W_2(\tau_2, \tau_3) - C_2(\tau_2, \tau_3)$. As for group 3 and group 4, their payoffs are given, respectively, by

$$(9) \quad W_3(\tau_2, \tau_3) = \Pi_3(p_3(\tau_2, \tau_3), \omega(\tau_2, \tau_3)) + \gamma_3 [T(\tau_2, \tau_3) + s(p_2^0 + \tau_2, p_3(\tau_2, \tau_3) + \tau_3)]$$

and

$$(10) \quad W_4(\tau_2, \tau_3) = \gamma_4 [\omega(\tau_2, \tau_3) + T(\tau_2, \tau_3) + s(p_2^0 + \tau_2, p_3(\tau_2, \tau_3) + \tau_3)]$$

The gross social welfare – before the political contributions are made – is then given by

$$(11) \quad W(\tau_2, \tau_3) = \Pi_1(1, \omega(\tau_2, \tau_3)) + \Pi_2(p_2^0 + \tau_2, \omega(\tau_2, \tau_3)) + \Pi_3(p_3(\tau_2, \tau_3), \omega(\tau_2, \tau_3)) \\ + \gamma_4 \omega(\tau_2, \tau_3) + T(\tau_2, \tau_3) + s(p_2^0 + \tau_2, p_3(\tau_2, \tau_3) + \tau_3)$$

and the net social welfare – as a function of the contingent political contribution schedule C_2 and the policy (τ_2, τ_3) is then given by $W(\tau_2, \tau_3) - C_2(\tau_2, \tau_3)$.

The payoff of the government is assumed to be given by

$$(12) \quad \begin{aligned} \Gamma(\tau_2, \tau_3, C_2) &= \lambda C_2(\tau_2, \tau_3) + W(\tau_2, \tau_3) - C_2(\tau_2, \tau_3) \\ &= (\lambda - 1)C_2(\tau_2, \tau_3) + W(\tau_2, \tau_3). \end{aligned}$$

In (12), λ represents the weight assigned to the political component of payoff. Note that in the payoff function, net social welfare receives a weight equal to 1. In order for the government to accept political contribution, it is necessary that $\lambda > 1$. If $\lambda \leq 1$, a transfer from any group to the government will decrease the latter player's payoff.

Now let

$$(13) \quad \mathfrak{R}(C_2) = \arg \max_{(\tau_2, \tau_3)} \Gamma(\tau_2, \tau_3, C_2).$$

As defined, $\mathfrak{R}(C_2)$ is the set of policies that are best against C_2 . The point-to-set map $\mathfrak{R} : C_2 \rightarrow \mathfrak{R}(C_2)$ represents the best-response correspondence of the government. We are now ready for a formal definition of the equilibrium of the principal-agent problem.

DEFINITION : Let $C_2^* : (\tau_2, \tau_3) \rightarrow C_2^*(\tau_2, \tau_3)$ be a feasible contingent payment schedule and (τ_2^*, τ_3^*) a policy. We say that the list $(C_2^*, \tau_2^*, \tau_3^*)$ is a Nash equilibrium for the game of endogenous policy formation if the following conditions are satisfied :

(a) $(\tau_2^*, \tau_3^*) \in \mathfrak{R}(C_2^*)$;

(b) For any feasible contingent payment schedule C_2 of group 2, we have

$$W_2(\tau_2^*, \tau_3^*) - C_2^*(\tau_2^*, \tau_3^*) \geq \sup_{(\tau_2, \tau_3) \in \mathfrak{R}(C_2)} [W_2(\tau_2, \tau_3) - C_2(\tau_2, \tau_3)]$$

Condition (a) asserts that (τ_2^*, τ_3^*) is a best response to C_2^* , while condition (b) asserts that C_2^* is a best strategy that the principal can adopt.

3. THE THIRD STAGE OF THE GAME: TAX POLICIES AND THEIR IMPACT ON RESOURCE ALLOCATION

In this section we analyze the third stage of the game. Suppose then that (τ_2, τ_3) is the tax policy implemented by policy makers in the second stage. To analyze the impact of tax policies on the pattern of resource allocation, we shall investigate the behavior of the system made up of the two market-clearing conditions (4) and (5).

First, let us look at the partial equilibrium in the market for the non-traded good. Suppose then that the wage rate is given. Given the wage rate, the market supply of the non-traded good is $p_3 \rightarrow Y_3(p_3, \omega_3)$ and the market demand for this good is $p_3 \rightarrow x_3(p_3 + \tau_3)$.

The market-clearing condition for the non-traded good is $x_3(p_3 + \tau_3) = Y_3(p_3, \omega_3)$. Let $\tilde{p}_3(\omega, \tau_3)$ denote the price that clears this market, given the wage rate ω and the tax τ_3 . The determination of the partial equilibrium in the market for the non-traded good, given the wage rate and the tax on the consumption of this good. We have the following comparative static results concerning the partial equilibrium in the market for the non-traded good.

First, note that an increase in the wage rate shifts the supply curve of the non-traded good upward, but has no impact on the market demand curve for this good. The new partial equilibrium involves a higher producer price, i.e., a higher value of p_3 , and a lower output of the non-traded good. A lower output means a lower demand for labor because the capital stock in the non-traded good sector is sector-specific. We have just shown that $\omega \rightarrow \tilde{p}_3(\omega, \tau_3)$ is increasing, but $\omega \rightarrow Y_3(\tilde{p}_3(\omega, \tau_3), \omega)$ and $\omega \rightarrow L_3(\tilde{p}_3(\omega, \tau_3), \omega)$ are both decreasing.

Second, note that an increase in τ_3 , the consumption tax on the non-traded good, leaves its supply curve unchanged, but shifts its demand curve downward. The new equilibrium involves a lower price, a lower quantity, and a fortiori a lower demand for labor by the non-traded good sector. That is, $\tau_3 \rightarrow \tilde{p}_3(\omega, \tau_3)$, $\tau_3 \rightarrow Y_3(\tilde{p}_3(\omega, \tau_3), \omega)$, and $\tau_3 \rightarrow L_3(\tilde{p}_3(\omega, \tau_3), \omega)$ are all decreasing.

Using the first comparative static result, we can assert that the aggregate demand for labor, namely

$$L(\tau_2, \tau_3, \cdot) : \omega \rightarrow L(\tau_2, \tau_3, \omega) = L_1(1, \omega) + L_2(p_2^0 + \tau_2, \omega) + L_3(\tilde{p}_3(\omega, \tau_3), \omega),$$

is strictly decreasing from $+\infty$ to 0 as ω rises from 0 to $+\infty$. Hence by continuity there exists a unique wage rate, say $\omega(\tau_2, \tau_3)$, that clears the labor market. The determination of the equilibrium wage rate, is a function of the policy implemented. When the wage rate $\omega(\tau_2, \tau_3)$ prevails, the equilibrium price of the non-traded good is given by $p_3(\tau_2, \tau_3) = \tilde{p}_3(\omega, \tau_3)$. The general equilibrium for the small open economy that is induced by the tax policy (τ_2, τ_3) is now completely determined.

LEMMA 1: *An increase in the tariff on the import of good 2, ceteris paribus, raises the wage rate and the price of the non-traded good. Labor moves out of sectors 1 and 3 into sector 2, causing the former sectors to contract and the latter sector to expand. Furthermore, after the new equilibrium has been established, the rents made by the owners of the specific input in sector 2 will have risen, while the rents accruing to the specific input in sector 1 will have declined. As for the rents accruing to the specific input in sector 3, it is not clear whether they will have risen or fallen..*

PROOF: A rise in τ_2 a fortiori raises $p_2^0 + \tau_2$, the domestic price of good 2. At any given wage rate, the rise in the price of good 2 will induce the domestic producers of this good to raise their output. Because capital is sector specific, a rise in output can only be attained by increasing the labor input. Thus a rise in τ_2 will shift the curve $\omega \rightarrow L_2(p_2^0 + \tau_2, \omega)$, the demand for labor by the non-traded good sector upward. On the other hand, a rise in τ_2 has no impact on the demand curve for labor by sector 1 and the demand curve for labor by the non-traded good sector. Thus at the initial equilibrium wage rate and immediately after the rise in τ_2 , there will be an excess demand for labor in the small open economy. To clear the labor market after the rise in τ_2 , the wage rate must rise. The rise in the equilibrium wage rate induces the sector producing the

numéraire as well as the non-traded good sector to decrease their labor inputs, which a fortiori implies a rise in the demand for labor by sector 2.

The new higher equilibrium wage rate that is induced by a rise in τ_2 clearly worsens the situation of the owners of the specific input used in the production of the numéraire. As for the owners of the specific input in sector 3, the rents they obtain will be higher. To see why, note that the rents accruing to the specific input in sector 2 is $(p_2^0 + \tau_2)\bar{K}_2 \partial F_2 / \partial L_2(\bar{K}_2, L_2)$. The rise in sector 2's demand for labor raises the marginal product of the specific input. This result together with the rise in $p_2^0 + \tau_2$ imply a rise in the rents accruing to the specific input in sector 2. As for sector 3, a lower labor input means a lower output and a higher price for the non-traded good. A rise in τ_2 thus causes the non-traded good sector to contract. Although the non-traded good sector contracts, the price of this good rises. Thus it is not clear whether the rents accruing to the specific input in this sector rise or fall. If the contraction is dramatic, we could expect the income of the owners of the specific input in this sector to fall. ■

The impact of a rise in the tax on the consumption of the non-traded good is given in the following lemma:

LEMMA 2: A rise in the tax on the consumption of the non-traded good, ceteris paribus, depresses the wage rate and causes the producer price of this good to fall. Both sectors 1 and 2 expand at the expense of sector 3. Furthermore, the rents accruing to the specific inputs in sector 1 and 2 both rise, while the rents accruing to the specific input in sector 1 decline.

PROOF : Recall from our comparative static analysis of the partial equilibrium in the non-traded good sector that a rise in τ_3 will shift the demand curve for labor by this sector downward, but has no impact on the demand curves for labor by the other two sectors. Hence a rise in the consumption tax in the non-traded good sector will shift the aggregate demand for labor downward, causing the equilibrium wage rate to fall. The lower wage

rate will induce sectors 1 and 2 to expand because the prices for goods 1 and 2 do not change. Also, the lower wage rate will cause the rents in these sectors to rise.

As for the impact on sector 3, a lower wage rate shifts the supply curve of the non-traded good downward. The rise in the tax on the consumption of this good will also shift the demand curve for this good downward. Hence a rise in the tax on the consumption of the non-traded good will cause its price to fall. Furthermore, because a rise in the tax on the consumption of the non-traded good causes the demand for labor in this sector to fall, the marginal product of capital in the non-traded good sector will be lower under the new equilibrium. Hence $p_3(\tau_2, \tau_3) \bar{K}_3 \partial F_3 / \partial K_3(\bar{K}_3, L_3(p_3(\tau_2, \tau_3), \omega(\tau_2, \tau_3)))$, the rents accruing to the specific input used in the production of the non-traded good, will decline when the tax on the consumption of this good rises. ■

We wish to emphasize that as a result of lobbying, it will be shown that the policy authority would enhance the protection of the traded sector. This protection, either through import-tariff or export subsidy, will be strengthened by the imposition of a consumption tax on the non-traded good. The overall effect of such policy is obtained from the combination of Lemma 1 and Lemma 2, which exhibit respectively the partial effect of the protectionist policy and the consumption tax (see also Corden and Neary, op.cit.).

4. THE ENDOGENOUS DETERMINATION OF POLICIES

4.1. *Welfare Maximization*

If policy makers' objective is to maximize social welfare, then the government solves the following maximization problem:

$$(14) \quad \max_{(\tau_2, \tau_3)} W(\tau_2, \tau_3) = \mu_0.$$

The following first-order conditions characterize a solution of (14):

$$(15) \quad D_1 W(\tau_2, \tau_3) = [D_1 \hat{Z}_2(\tau_2, \tau_3)] \tau_2 + [D_1 \hat{Y}_3(\tau_2, \tau_3)] \tau_3 = 0,$$

$$(16) \quad D_2 W(\tau_2, \tau_3) = [D_2 \hat{Z}_2(\tau_2, \tau_3)]\tau_2 + [D_2 \hat{Y}_3(\tau_2, \tau_3)]\tau_3 = 0.$$

In (15) and (16), we have let

$$\hat{Z}_2(\tau_2, \tau_3) = x_2(p_2^0 + \tau_2) - Y_2(p_2^0 + \tau_2, \omega(\tau_2, \tau_3))$$

and

$$\hat{Y}_3(\tau_2, \tau_3) = Y_3(p_3(\tau_2, \tau_3), \omega(\tau_2, \tau_3))$$

denote, respectively, the equilibrium level of the import of good 2 and the equilibrium output of the non-traded good under the policy (τ_2, τ_3) . See the appendix for the detailed calculations leading to (15) and (16).

Now define

$$\Delta(\tau_2, \tau_3) = [D_1 \hat{Z}_2(\tau_2, \tau_3)][D_2 \hat{Y}_3(\tau_2, \tau_3)] - [D_2 \hat{Z}_2(\tau_2, \tau_3)][D_1 \hat{Y}_3(\tau_2, \tau_3)].$$

Now as τ_2 rises, the demand for good 2 declines. Furthermore, according to Lemma 1, its supply goes up as τ_2 rises. Hence $D_1 \hat{Z}_2(\tau_2, \tau_3) < 0$. Also, by Lemma 1, we have $D_1 \hat{Y}_3(\tau_2, \tau_3) < 0$. Next, recall from Lemma 2 that when τ_3 rises the output of good 2 goes up, but the output of good 3 goes down. Also, rise in τ_3 alone does not affect the demand for good 2. Hence $D_2 \hat{Z}_2(\tau_2, \tau_3) < 0$ and $D_2 \hat{Y}_3(\tau_2, \tau_3) < 0$. Without further restrictions, we cannot determine the sign of $\Delta(\tau_2, \tau_3)$ unambiguously. If we let $\eta_{2,i}(\tau_2, \tau_2)$ and $\eta_{3,i}(\tau_2, \tau_2)$ denote, respectively, the elasticity of $\hat{Z}_2(\tau_2, \tau_3)$ and the elasticity of $\hat{Y}_3(\tau_2, \tau_3)$ with respect to τ_i , then $\Delta(\tau_2, \tau_3)$ can be rewritten as follows :

$$\begin{aligned} \Delta(\tau_2, \tau_3) &= [D_1 \hat{Z}_2(\tau_2, \tau_3)][D_2 \hat{Y}_3(\tau_2, \tau_3)] \left(1 - \frac{[D_2 \hat{Z}_2(\tau_2, \tau_3)][D_1 \hat{Y}_3(\tau_2, \tau_3)]}{[D_1 \hat{Z}_2(\tau_2, \tau_3)][D_2 \hat{Y}_3(\tau_2, \tau_3)]} \right) \\ &= [D_1 \hat{Z}_2(\tau_2, \tau_3)][D_2 \hat{Y}_3(\tau_2, \tau_3)] \left(1 - \frac{\eta_{2,3}(\tau_2, \tau_3)\eta_{3,2}(\tau_2, \tau_3)}{\eta_{2,2}(\tau_2, \tau_3)\eta_{3,3}(\tau_2, \tau_3)} \right). \end{aligned}$$

Intuitively, we expect that the *own-price effect* dominates the *cross-price effect*, i.e.,

$$(17) \quad \left| \frac{\eta_{2,3}(\tau_2, \tau_3)}{\eta_{2,2}(\tau_2, \tau_3)} \right| < 1$$

and

$$(18) \quad \left| \frac{\eta_{3,2}(\tau_2, \tau_3)}{\eta_{3,3}(\tau_2, \tau_3)} \right| < 1.$$

Thus if the inequalities (17) and (18) are satisfied, then $\Delta(\tau_2, \tau_3) > 0$. In this case, the only values of τ_2 and τ_3 that satisfy the system constituted by (15) and (16) are $\tau_2 = \tau_3 = 0$. We summarize the results just obtained in the following proposition :

PROPOSITION 1 : *Suppose that (17) and (18) hold, i.e., for the excess demand of good 2 and for the supply of the non-traded good, the own-price effect dominates the cross-price effect of a policy change. Then $\Delta(\tau_2, \tau_3)$, the discriminant of the system constituted by (15) and (16), is positive, and the policy that maximizes social welfare is that of no government intervention.*

4.2. Determination of Endogenous Policy

If (τ_2, τ_3) is a policy that group 2 wishes the government to implement, then the shortfall in the social welfare component of the government's payoff is $\mu_0 - W(\tau_2, \tau_3)$. Here we recall that μ_0 – as defined by (13) – the government's reservation payoff and $W(\tau_2, \tau_3)$ is the social welfare before political contributions are made. To induce the government into implementing this policy, group 2 must promise a payment of at least $(\mu_0 - W(\tau_2, \tau_3))/(\lambda - 1)$. The net payoff of group 2 – after the payment has been made – is then equal to $W_2(\tau_2, \tau_3) - \frac{\mu_0 - W(\tau_2, \tau_3)}{\lambda - 1}$. Hence the policy that the owners of the specific input used in the production of good 2 is the solution of the following maximization problem :

$$(19) \quad \max_{(\tau_2, \tau_3)} \left[W_2(\tau_2, \tau_3) - \frac{\mu_0 - W(\tau_2, \tau_3)}{\lambda - 1} \right] = \mu_2.$$

The following first-order conditions characterize a solution of (19)

$$(20) \quad D_1 W_2(\tau_2, \tau_3) + \frac{1}{\lambda - 1} D_1 W(\tau_2, \tau_3) = 0,$$

$$(21) \quad D_2 W_2(\tau_2, \tau_3) + \frac{1}{\lambda - 1} D_2 W(\tau_2, \tau_3) = 0.$$

Using the expressions for $D_1 W(\tau_2, \tau_3)$ and $D_2 W(\tau_2, \tau_3)$, which are given by the right sides of the first equalities in (15) and (16), respectively, and letting $\hat{\lambda} = 1 - \lambda < 0$, we can rewrite these first-order conditions as follows.

$$(22) \quad [D_1 \hat{Z}_2(\tau_2, \tau_3)]\tau_2 + [D_1 \hat{Y}_3(\tau_2, \tau_3)]\tau_3 = \hat{\lambda} D_1 W_2(\tau_2, \tau_3),$$

$$(23) \quad [D_2 \hat{Z}_2(\tau_2, \tau_3)]\tau_2 + [D_2 \hat{Y}_3(\tau_2, \tau_3)]\tau_3 = \hat{\lambda} D_2 W_2(\tau_2, \tau_3).$$

The policy, say (τ_2^*, τ_3^*) , that solves the system constituted by (22) and (23) satisfies the following conditions:

$$(24) \quad \begin{aligned} \tau_2^* &= \frac{\hat{\lambda}}{\Delta(\tau_2^*, \tau_3^*)} \left[D_1 W_2(\tau_2^*, \tau_3^*) D_2 \hat{Y}_3(\tau_2^*, \tau_3^*) - D_2 W_2(\tau_2^*, \tau_3^*) D_1 \hat{Y}_3(\tau_2^*, \tau_3^*) \right] \\ &= \frac{\hat{\lambda}}{\Delta(\tau_2^*, \tau_3^*)} D_1 W_2(\tau_2^*, \tau_3^*) D_2 \hat{Y}_3(\tau_2^*, \tau_3^*) \left[1 - \frac{D_2 W_2(\tau_2^*, \tau_3^*) D_1 \hat{Y}_3(\tau_2^*, \tau_3^*)}{D_1 W_2(\tau_2^*, \tau_3^*) D_2 \hat{Y}_3(\tau_2^*, \tau_3^*)} \right] \\ &= \frac{\hat{\lambda}}{\Delta(\tau_2^*, \tau_3^*)} D_1 W_2(\tau_2, \tau_3) D_2 \hat{Y}_3(\tau_2, \tau_3) \left[1 - \frac{\varsigma_{2,3}(\tau_2^*, \tau_3^*) \eta_{3,2}(\tau_2^*, \tau_3^*)}{\varsigma_{2,2}(\tau_2^*, \tau_3^*) \eta_{3,2}(\tau_2^*, \tau_3^*)} \right] \end{aligned}$$

and

$$(25) \quad \begin{aligned} \tau_3^* &= \frac{\hat{\lambda}}{\Delta(\tau_2^*, \tau_3^*)} \left[D_2 W_2(\tau_2^*, \tau_3^*) D_1 \hat{Z}_2(\tau_2^*, \tau_3^*) - D_1 W_2(\tau_2^*, \tau_3^*) D_2 \hat{Z}_2(\tau_2^*, \tau_3^*) \right] \\ &= \frac{\hat{\lambda}}{\Delta(\tau_2^*, \tau_3^*)} D_2 W_2(\tau_2^*, \tau_3^*) D_1 \hat{Z}_2(\tau_2^*, \tau_3^*) \left[1 - \frac{D_1 W_2(\tau_2^*, \tau_3^*) D_2 \hat{Z}_2(\tau_2^*, \tau_3^*)}{D_2 W_2(\tau_2^*, \tau_3^*) D_1 \hat{Z}_2(\tau_2^*, \tau_3^*)} \right] \\ &= \frac{\hat{\lambda}}{\Delta(\tau_2^*, \tau_3^*)} D_2 W_2(\tau_2^*, \tau_3^*) D_1 \hat{Z}_2(\tau_2^*, \tau_3^*) \left[1 - \frac{\varsigma_{2,2}(\tau_2^*, \tau_3^*) \eta_{2,3}(\tau_2^*, \tau_3^*)}{\varsigma_{2,3}(\tau_2^*, \tau_3^*) \eta_{2,2}(\tau_2^*, \tau_3^*)} \right]. \end{aligned}$$

In (24) and (25), the elasticities $\eta_{i,j}(\tau_1, \tau_2), i, j = 2, 3$, are as defined before, while $\varsigma_{2,j}(\tau_1, \tau_2), j = 2, 3$, denotes the elasticity of $W_2(\tau_2, \tau_3)$ with respect to $\tau_j, j = 2, 3$.

Let us now determine the sign of τ_2^* and τ_3^* . In the same manner that we expect the inequalities (17) and (18) to hold, we should also expect that for the gross payoff of group 2, the own-price elasticity will dominate the cross-price elasticity, i.e.,

$$(26) \quad \varsigma_{2,3}(\tau_2, \tau_3) < \varsigma_{2,2}(\tau_2, \tau_3).$$

Hence when (17), (18), and (26) hold, the expressions inside the square brackets on the last lines of (24) and (25) will both be positive. Next, recall from Proposition 1 that when (17) and (18) hold, the discriminant $\Delta(\tau_2^*, \tau_3^*)$ will be positive. Also, recall from Lemma 2 that $D_2 \hat{Y}_3(\tau_2^*, \tau_3^*) < 0$. Because $\hat{\lambda} < 0$, τ_2^* will be positive or negative depends on whether $D_1 W_2(\tau_2^*, \tau_3^*)$ is positive or negative.

Now $W_2(\tau_2, \tau_3)$, the gross payoff of group 2, has three components : rents, government transfer, and consumer surplus. When τ_2 rises, the rents component also rise, according to Lemma 1. A rise in τ_2 a fortiori means a rise in the domestic price of good 2, causing the consumer surplus associated with the consumption of this good to decline. Also, according to Lemma 1, a rise in τ_2 will induce a rise in the consumer price of the non-traded good, causing the consumer surplus associated with the consumption of this good to decline. As for the government transfer component, if good 2 is exported, a rise in τ_2 means an increase in the subsidy given to the export of this commodity, resulting in a heavier tax burden on each individual of the small open economy. If good 2 is imported, a rise in τ_2 raises the tariff revenues collected on the imports of this commodity. Furthermore, if the tax on the consumption of the non-traded good is positive, the decline in its production – induced by a rise in τ_2 – will lead to a lower level of tax revenues collected from this sector. On the other hand, if the consumption of the non-traded good is subsidized, then a rise in τ_2 will reduce the subsidy given to the consumption of this good. The overall impact of a rise in τ_2 on the payoff of group 2 depends on the net effects of these conflicting movements of the three components in the gross payoff of group 2. However, when the ownership of the specific input in sector 2 is highly concentrated, i.e., when γ_2 is very small, we can ignore the government transfer and the

consumer surplus components in the gross payoff for good 2. In this case, the gross payoff of group 2 can be approximated by the rents accruing to the specific input in sector 2, and we have $D_1W_2(\tau_2^*, \tau_3^*) > 0$. We have just shown that if the ownership of the specific input in sector 2 is highly concentrated and if the own-price effects dominate the cross-price effects, then the owners of the specific input in sector 2 will be able to lobby policy makers either for a tariff or an export subsidy for good 2. In general, if $D_1W_2(\tau_2, \tau_3) < 0$, then it does not pay for group 2 to organize, and we will not witness any lobbying activities by the owners of the specific input in sector 2.

As for τ_3^* , in general, its sign depends on the sign of $D_2W_2(\tau_2^*, \tau_3^*)$. According to Lemma 2, a rise in the tax on the consumption of the non-traded good depresses the wage rate and cause the producer price of the non-traded good to fall. Both sectors 1 and 2 expand at the expense of sector 3. For the owners of the specific input in sector 2, they see the rents they obtain rise with τ_3 . The consumer surplus that they obtain from the consumption of good 2 also rises. However, it is not clear whether the surplus that they obtain from the consumption of the non-traded good rises or falls because the consumer price of this commodity goes up, but its demand goes down. As in the analysis on the sign of τ_2^* , if the ownership of the specific input in sector 2 is highly concentrated, then we will have $D_2W_2(\tau_2^*, \tau_3^*) > 0$, which leads to $\tau_3^* > 0$. We have the following results :

PROPOSITION 2: Suppose that the inequalities (17), (18), and (26) hold, i.e., the own-price effects dominate the cross-price effects. If the ownership of the specific input in sector 2 is highly concentrated, then through its lobbying activities, group 2 will manage to obtain support for its industry, either through an import tariff or an export subsidy. Furthermore, its lobbying activities will induce the government to impose a tax on the consumption of the non-traded good. Also, the lobbying activities of group 2 result in the expansion of sector 2 and a contraction of sector 3. As for sector 1, it is not clear whether it expands or contracts.

PROOF : The first two statements of the proposition have been established. To establish the last two, let us imagine that starting from the initial state of non-intervention, policy maker implement first the policy τ_2^* , then the policy τ_3^* . According to Lemma 1, when τ_2 rises from 0 to τ_2^* , sector 2 expands, but sector 1 and sector 3 contract. The next policy movement from $(\tau_2^*, 0)$ to (τ_2^*, τ_3^*) causes sector 2 to expand further; sector 1 to expand; and sector 3 to contract further. The overall impacts of the lobbying activities of group 2 are a net expansion of sector 2 and a net contraction of sector 3. As for the net impact on the sector that produces the numéraire, it is not clear whether this sector expands or contracts. ■

4.3. A Solution of the Endogenous Policy Problem

The tax policy (τ_2^*, τ_3^*) found in Section 4.2 maximizes the net payoff of group 2 while respecting the participating constraint. Group 2 extracts all the surplus generated by the participation of the government. A contingent payment schedule that allows group 2 to maximize its net payoff is

$$(27) \quad C_2^* : (\tau_2, \tau_3) \rightarrow C_2^*(\tau_2, \tau_3) = \max[W_2(\tau_2, \tau_3) - \mu_2]$$

Bernheim and Whinston, op. cit., label such a contingent payment schedule a *truthful strategy*. In adopting the strategy represented by (27), group 2 only aims for a net payoff of μ_2 . More precisely, if its gross payoff is less than μ_2 , then it will not make any political contribution. On the other hand, any payoff in excess of μ_2 will be offered to the government as political contributions. For the government, a best response to C_2^* is (τ_2^*, τ_3^*) . Hence the list $(C_2^*, \tau_2^*, \tau_3^*)$ is a *truthful Nash equilibrium* for the game of endogenous trade policy formation.

5. WHAT IS NEXT AFTER LOBBYING?

For a small open developing economy where the practice of buying political influence – through either corruption, bribery, gifts etc ... – is relatively widespread, policy formation is endogenous in that it results from the interplay of special-interest groups' advantages and policy makers' gains from the contributions made by the special-interest groups. We adopt the influence-driven approach of Grossman and Helpman to analyze the question of endogenous trade policy for an economy with three production sectors – a sector producing a good which is freely traded and which is taken to be the numéraire, a manufacturing sector producing a traded good, and an agricultural sector producing a non-traded good because it has no access to international markets. Neither workers nor owners of the specific factor in agriculture – group 3 and group 4 in our model – could get organized as special-interest groups to lobby policy makers. We assume that lobbying activities will only be carried out by group 2 – the owners of the specific factor in the manufacturing sector – and show that lobbying would secure a protectionist trade policy through either an import tariff or an export subsidy in this sector. Furthermore, this group also benefits from the consumption tax imposed on the consumption of the non-traded agricultural products. Labor moves to the manufacturing sector, and as a result, an output expansion in the manufacturing sector, and an output contraction in the agricultural sector. The rent made by the owners of the specific factor in the manufacturing sector will rise after the new equilibrium has been established. As to the rent made by the owners of the specific factor in the agricultural sector, it may rise or fall, depending on the values of the parameters of the model. As for the wage rate, it goes up after an increase in the tariff in manufacturing sector (Lemma 1), but goes down after the imposition of a consumption tax in the agricultural sector (Lemma 2), thus all in all may rise or fall as a result of lobbying.

What will be happening if we allow the owners of the specific factor in agriculture to participate in the lobbying game of policy formation? Obviously, their interests will go against the adoption of the consumption tax on agricultural products. Government officials, now the common agency, will see competitive bids from many lobbies, and the policies resulting from this process would be, from the viewpoint of the lobbies involved,

more “balanced.” This task has been undertaken,⁶ and there will not be a unique Truthful Nash Equilibrium, as in the present paper. In a developing nation, farmers often work on little plots of land that geographically spread all around the countryside. This certainly does not help in allowing farmers to become organized as a special-interest group.

We may ask the same question with regard to the workers and try to find out how they behave as an organized lobby. Each worker sees her wage changed at the new equilibrium because of lobbying activities by the owners of the specific factor in the manufacturing sector, receives a lump-sum transfer, but has to pay higher prices for their consumption of manufacturing and agricultural products, thus enjoying a lower consumer surplus. Her “real income”, which is represented by equation (3), should fall in comparison with that obtained in the absence of lobbying, i.e., under non-intervention (Proposition 1). If we assume that workers could engage in the influence-driven game, they will obviously lobby for no policy intervention, thus lessen the impact of lobbying activities carried out by owners of the specific factor in the manufacturing sector. However, in the vast majority of developing countries, workers are not organized. When workers are organized, they tend to constitute small groups working in urban cities, not in rural areas.

What is left for workers as a means to defend their interest? In a democracy where the majority voting is the rule to elect the government, workers might express their interest through the periodic polls. Since the “real income” of the median voter declines as a result of trade policies induced from lobbying activities, voters would never have any advantage to keep the ruling government in power. This is one among the multiple causes of endemic instability inherent in any democratic regime in rural developing countries. And if workers do not believe in the voting process, they are left only with sporadic manifestations through unrest. This probably offers an explanation for the casual observation that so many totalitarian governments and political dictatorship exist in some developing nations. The current call from the industrialized countries in the West for implementing political democracy and fighting against poverty in developing nations is

⁶ See footnote 5.

perhaps a lulling melody in the desert, unless they put an end to their protectionist policies in agriculture, eliminate all insidious trade barriers, and open their agricultural markets to the poor countries. As our analysis suggests, free trade would certainly help reducing poverty and enhancing the political stability in the Third World.

APPENDIX

THE DERIVATIONS OF EQUATIONS (15) AND (16)

Substituting the expression for the total tax revenue collected and the expression for total consumer surplus into the expression of gross social welfare, we obtain

$$\begin{aligned}
 (A.1) \quad W(\tau_2, \tau_3) = & \Pi_1(1, \omega(\tau_2, \tau_3)) + \Pi_2(p_2^0 + \tau_2, \omega(\tau_2, \tau_3)) + \Pi_3(p_3(\tau_2, \tau_3), \omega(\tau_2, \tau_3)) \\
 & + \gamma_4 \omega(\tau_2, \tau_3) + \tau_2 [x_2(p_2^0 + \tau_2) - Y_2(p_2^0 + \tau_2, \omega(\tau_2, \tau_3))] \\
 & + \tau_3 x_3(p_3(\tau_2, \tau_3) + \tau_3) + u_2(x_2(p_2^0 + \tau_2)) - (p_2^0 + \tau_2)x_2(p_2^0 + \tau_2) \\
 & + u_3(x_3(p_3(\tau_2, \tau_3) + \tau_3)) - (p_3(\tau_2, \tau_3) + \tau_3)x_3(p_3(\tau_2, \tau_3) + \tau_3).
 \end{aligned}$$

Differentiating (A.1) with respect to τ_2 , we obtain

$$\begin{aligned}
 (A.2) \quad D_1 W(\tau_2, \tau_3) = & D_2 \Pi_1(1, \omega(\tau_2, \tau_3)) D_1 \omega(\tau_2, \tau_3) \\
 & + D_1 \Pi_2(p_2^0 + \tau_2, \omega(\tau_2, \tau_3)) + D_2 \Pi_2(p_2^0 + \tau_2, \omega(\tau_2, \tau_3)) D_1 \omega(\tau_2, \tau_3) \\
 & + D_1 \Pi_3(p_3(\tau_2, \tau_3), \omega(\tau_2, \tau_3)) D_1 p_3(\tau_2, \tau_3) \\
 & + D_2 \Pi_3(p_3(\tau_2, \tau_3), \omega(\tau_2, \tau_3)) D_1 \omega(\tau_2, \tau_3) \\
 & + \gamma_4 D_1 \omega(\tau_2, \tau_3) + [x_2(p_2^0 + \tau_2) - Y_2(p_2^0 + \tau_2, \omega(\tau_2, \tau_3))] \\
 & + \tau_2 \left[\begin{aligned} & D x_2(p_2^0 + \tau_2) - D_1 Y_2(p_2^0 + \tau_2, \omega(\tau_2, \tau_3)) \\ & - D_2 Y_2(p_2^0 + \tau_2, \omega(\tau_2, \tau_3)) D_1 \omega(\tau_2, \tau_3) \end{aligned} \right] \\
 & + \tau_3 D x_3(p_3(\tau_2, \tau_3) + \tau_3) D_1 p_3(\tau_2, \tau_3) \\
 & + D u_2(x_2(p_2^0 + \tau_2)) - x_2(p_2^0 + \tau_2) - (p_2^0 + \tau_2) D x_2(p_2^0 + \tau_2) \\
 & + D u_3(x_3(p_3(\tau_2, \tau_3) + \tau_3)) D x_3(p_3(\tau_2, \tau_3) + \tau_3) D_1 p_3(\tau_2, \tau_3) \\
 & - D_1 p_3(\tau_2, \tau_3) x_3(p_3(\tau_2, \tau_3) + \tau_3) - (p_3(\tau_2, \tau_3) + \tau_3) D x_3(p_3(\tau_2, \tau_3) + \tau_3) D_1 p_3(\tau_2, \tau_3)
 \end{aligned}$$

Applying Hotelling lemma to the profits functions of the two sectors; using the fact that the marginal utilities of good 2 and 3 are equal, respectively, to their prices; and using the market-clearing conditions for labor and the non-traded good, we can rewrite (A.1) as follows.

$$\begin{aligned}
D_1W(\tau_2, \tau_3) = & -L_1(1, \omega(\tau_2, \tau_3))D_1\omega(\tau_2, \tau_3) \\
& + Y_2(p_2^0 + \tau_2, \omega(\tau_2, \tau_3)) - L_2(p_2^0 + \tau_2, \omega(\tau_2, \tau_3))D_1\omega(\tau_2, \tau_3) \\
& + Y_3(p_3(\tau_2, \tau_3), \omega(\tau_2, \tau_3))D_1p_3(\tau_2, \tau_3) \\
& - L_3(p_3(\tau_2, \tau_3), \omega(\tau_2, \tau_3))D_1\omega(\tau_2, \tau_3) \\
& + \gamma_4 D_1\omega(\tau_2, \tau_3) + [x_2(p_2^0 + \tau_2) - Y_2(p_2^0 + \tau_2, \omega(\tau_2, \tau_3))] \\
(A.3) \quad & + \tau_2 \left[Dx_2(p_2^0 + \tau_2) - D_1Y_2(p_2^0 + \tau_2, \omega(\tau_2, \tau_3)) \right] \\
& + \tau_3 Dx_3(p_3(\tau_2, \tau_3) + \tau_3)D_1p_3(\tau_2, \tau_3) \\
& + (p_2^0 + \tau_2)Dx_2(p_2^0 + \tau_2) - x_2(p_2^0 + \tau_2) - (p_2^0 + \tau_2)Dx_2(p_2^0 + \tau_2) \\
& + (p_3(\tau_2, \tau_3) + \tau_3)Dx_3(p_3(\tau_2, \tau_3) + \tau_3)D_1p_3(\tau_2, \tau_3) \\
& - D_1p_3(\tau_2, \tau_3)x_3(p_3(\tau_2, \tau_3) + \tau_3) - (p_3(\tau_2, \tau_3) + \tau_3)Dx_3(p_3(\tau_2, \tau_3) + \tau_3)D_1p_3(\tau_2, \tau_3)
\end{aligned}$$

Simplifying (A.3), we obtain

$$\begin{aligned}
D_1W(\tau_2, \tau_3) = & \tau_2 \left[Dx_2(p_2^0 + \tau_2) - D_1Y_2(p_2^0 + \tau_2, \omega(\tau_2, \tau_3)) \right] \\
(A.4) \quad & + \tau_3 Dx_3(p_3(\tau_2, \tau_3) + \tau_3)D_1p_3(\tau_2, \tau_3).
\end{aligned}$$

Letting

$$\hat{Z}_2(\tau_2, \tau_3) = x_2(p_2^0 + \tau_2) - Y_2(p_2^0 + \tau_2, \omega(\tau_2, \tau_3))$$

and

$$\hat{Y}_3(\tau_2, \tau_3) = Y_3(p_3(\tau_2, \tau_3), \omega(\tau_2, \tau_3)),$$

We can rewrite (A.4) as

$$(A.5) \quad D_1W(\tau_2, \tau_3) = [D_1\hat{Z}_2(\tau_2, \tau_3)]\tau_2 + [D_1\hat{Y}_3(\tau_2, \tau_3)]\tau_3 = 0,$$

which is (15) in Section 4.1.

Differentiating (A.1) with respect to τ_3 , we obtain

$$\begin{aligned}
D_2W(\tau_2, \tau_3) &= D_2\Pi_1(1, \omega(\tau_2, \tau_3))D_2\omega(\tau_2, \tau_3) \\
&+ D_2\Pi_2(p_2^0 + \tau_2, \omega(\tau_2, \tau_3))D_2\omega(\tau_2, \tau_3) \\
&+ D_1\Pi_3(p_3(\tau_2, \tau_3), \omega(\tau_2, \tau_3))D_2p_3(\tau_2, \tau_3) \\
&+ D_2\Pi_3(p_3(\tau_2, \tau_3), \omega(\tau_2, \tau_3))D_2\omega(\tau_2, \tau_3) \\
&+ \gamma_4 D_2\omega(\tau_2, \tau_3) \\
&- \tau_2 D_2Y_2(p_2^0 + \tau_2, \omega(\tau_2, \tau_3))D_2\omega(\tau_2, \tau_3) \\
&+ x_3(p_3(\tau_2, \tau_3) + \tau_3) + \tau_3 Dx_3(p_3(\tau_2, \tau_3) + \tau_3)D_2p_3(\tau_2, \tau_3) \\
&+ Du_3(x_3(p_3(\tau_2, \tau_3) + \tau_3))Dx_3(p_3(\tau_2, \tau_3) + \tau_3)[D_2p_3(\tau_2, \tau_3) + 1] \\
&- [D_2p_3(\tau_2, \tau_3) + 1]x_3(p_3(\tau_2, \tau_3) + \tau_3) \\
&- (p_3(\tau_2, \tau_3) + \tau_3)Dx_3(p_3(\tau_2, \tau_3) + \tau_3)[D_2p_3(\tau_2, \tau_3) + 1]
\end{aligned}
\tag{A.6}$$

Again using the same procedure to obtain (A.3), we can rewrite (A.6) as follows.

$$\begin{aligned}
D_2W(\tau_2, \tau_3) &= -L_1(1, \omega(\tau_2, \tau_3))D_2\omega(\tau_2, \tau_3) \\
&+ -L_2(p_2^0 + \tau_2, \omega(\tau_2, \tau_3))D_2\omega(\tau_2, \tau_3) \\
&+ Y_3(p_3(\tau_2, \tau_3), \omega(\tau_2, \tau_3))D_2p_3(\tau_2, \tau_3) \\
&- L_3(p_3(\tau_2, \tau_3), \omega(\tau_2, \tau_3))D_2\omega(\tau_2, \tau_3) \\
&+ \gamma_4 D_2\omega(\tau_2, \tau_3) \\
&- \tau_2 D_2Y_2(p_2^0 + \tau_2, \omega(\tau_2, \tau_3))D_2\omega(\tau_2, \tau_3) \\
&+ \tau_3 Dx_3(p_3(\tau_2, \tau_3) + \tau_3)D_2p_3(\tau_2, \tau_3) \\
&+ (p_3(\tau_2, \tau_3) + \tau_3)Dx_3(p_3(\tau_2, \tau_3) + \tau_3)[D_2p_3(\tau_2, \tau_3) + 1] \\
&- [D_2p_3(\tau_2, \tau_3)]x_3(p_3(\tau_2, \tau_3) + \tau_3) \\
&- (p_3(\tau_2, \tau_3) + \tau_3)Dx_3(p_3(\tau_2, \tau_3) + \tau_3)[D_2p_3(\tau_2, \tau_3) + 1]
\end{aligned}
\tag{A.7}$$

Simplifying (A.7), and using the definitions of $\hat{Z}_2(\tau_2, \tau_3)$ and $\hat{Y}_3(\tau_2, \tau_3)$, we obtain

$$\begin{aligned}
D_2W(\tau_2, \tau_3) &= -\tau_2 D_2Y_2(p_2^0 + \tau_2, \omega(\tau_2, \tau_3))D_2\omega(\tau_2, \tau_3) \\
&+ \tau_3 Dx_3(p_3(\tau_2, \tau_3) + \tau_3)D_2p_3(\tau_2, \tau_3) \\
&= [D_2\hat{Z}_2(\tau_2, \tau_3)]\tau_2 + [D_2\hat{Y}_3(\tau_2, \tau_3)]\tau_3 = 0,
\end{aligned}
\tag{A.8}$$

which is equation(16) of Section 4.1.

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