# economics Division Working Papers

# Development Issues

## Endogenous behaviour of tariff rates in the general equilibrium of a political economy

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**Key to symbols used in tables**

|        |                |
| ------ | -------------- |
| n.a.   | Not applicable |
| ..     | Not available  |
| -      | Zero           |
| .      | Insignificant  |

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# *a* bstract

Political activities in the 'political sphere' have been viewed as reflecting the bargaining process among the interest groups, the owners of the specific factors in the exporting and the import-competing sectors, seeking a favourable tariff rate. A condition characterising the Nash bargaining solution has been obtained and combined with the conditions of equilibrium in a Ricardo-Viner type model of the 'economic sphere' to obtain the general equilibrium of a political economy. The tariff rate emerging at the equilibrium of the political economy has been subjected to comparative static analysis. It is found that the bargained tariff rate changes to compensate, at least in part, for the relative loss of the loser arising from changes in the exogenous environment. This model has also been applied to explain some of the real world phenomenon such as why the developing economies tax, and the developed economies subsidise, agriculture

# *e*ndogenous behaviour of tariff rates in the general equilibrium of a political economy

A study of tariff determination is important for two reasons. First, tariff changes have distributive and allocative implications and therefore have been a source of major social and political conflicts. Second, the existence of tariffs is difficult to explain on social welfare grounds under complete and perfect market conditions. This paper attempts to explain how tariffs are determined endogenously in a political economy without resorting to any social welfare function and shows the comparative static responses of tariff rates as the exogenous environment changes.

There exists a vast literature on rent seeking, public choice and the political economy which contends that government policies in general, and the tariff policy in particular, are determined in the political market where the policy variables play the role of balancing the opposing political forces motivated by different consequences of policies in the economic sphere. These studies have invariably adopted a non-cooperative game-theoretic framework in modelling the process of tariff (policy) formation in a political economy (Hall and Nelson 1992, Coggins et al. 1991). However, given the assumption that the players are rational, the assumption that characterising their political behaviour as a non-cooperative game appears to be potentially inconsistent as a cooperative outcome may Pareto dominate non-cooperative outcomes.

This paper views tariff determination as a bargaining problem between the owners of the specific factors in the import-competing and exporting sectors, which constitutes a major departure from the existing political economy literature on tariff formation. The condition characterising a Nash bargaining solution has been combined with the conditions of equilibrium in a Ricardo-Viner type model of the economic sphere to derive the conditions for general equilibrium in a tariff-endogenous model of a political economy. A tariff rate that emerges as the

solution of this model simultaneously satisfies the condition of equilibrium in the political as well as the economic spheres of the political economy. A comparative static (counterfactual experiments) approach has been adopted to derive the endogenous behaviour of tariff rates in the general equilibrium. A major conclusion of the paper is that tariff rates change to compensate, at least partly, for the relative loss of the loser (compared to that of the other player) arising from changes in the exogenous environment.

This result is consistent with the predictions that follow from the maximisation of a conservative social welfare function as defined in Corden (1974). An implication is that if bargaining is acceptable as the underlying process that generates the (positive) conservative social welfare function then existing problems in defining a social welfare function will be resolved (Ng 1981). Also, the implementation of such a 'social welfare' function will be consistent with the self-interested behaviour of the government.

This paper has been divided into ten sections. In the second section, a Ricardo-Viner type model of the economic sphere has been specified. Based on this model, a rent transformation frontier and its basic properties have been derived. In section three, the political sphere has been characterised and the bargaining problem specified. In section four, the condition for a Nash solution to the bargaining problem has been obtained and combined with the conditions of equilibrium in the economic sphere to obtain a general equilibrium model of a political economy. The disagreement payoffs to the players under two different government behaviours are discussed in section five. Section six and seven are devoted to comparative static exercises. Comparative static results under the unconstrained government behaviour have been derived and their intuitive explanations have been provided in section six. In section seven, the model has been numerically simulated for six different political economies to observe the behaviour of the tariff rate under constrained government behaviour. Some hypotheses have been drawn from the results. In section eight, the credibility of the hypotheses have been assessed on the basis of existing literature. In section nine, the model has been applied to predict the consequence of a very large increase in the stock of the specific factor in the import-competing sector. Section ten summarises the paper.

# A tariff-exogenous general equilibrium model of the economic sphere of a political economy: PXGEM

A small open economy producing two tradable goods is considered. Good 1 is import-competing and good 2 is an exportable under free trade. These two goods are produced by two industries using mobile and homogenous labour and sector-specific capital stocks. The endowment of factors is exogenous. The production technology of each sector is characterised by a constant returns to scale CES production function. In this economy, the imported goods are considered perfect substitutes to home goods. The government imposes trade taxes and transfers the proceeds to the households. Trade taxes are the only wedge between domestic and world prices. To simplify further, it is assumed that all trade taxes (tariff and export subsidies) can be expressed as an equivalent rate of rationalised tariff imposed on the imports of good 1. The endogenous variables are defined as follows: $Y_j, C_j, M_j$ are respectively the sectoral outputs, domestic demands, net imports of the two commodities; $L_j$ represents sectoral employment of labour and $R_j$ represents sectoral rental rates; $W$ is the nominal wage rate and $P_1$ is the domestic relative price of the import-competing good. The remaining five variables, namely the rationalised tariff rate, $T_1^R$, the stocks of sector-specific capital, $K_1$ and $K_2$, the stock of labour in the economy, $L$, and the relative price of commodity 1 in the world market, $P_1^*$, are exogenously given. Commodity 2 has been chosen as a numeraire. This model contains six parameters, of which $\sigma_j = 1/(1+\rho_j)$ represents the elasticity of factor substitution, $\alpha_j$ and $\beta_j$ are share parameters of the CES production function in sector $j$; and $\delta_j$ is the share of commodity $j$ in the budget of the representative consumer.

The domestic relative prices of the commodities are exogenously determined, to the extent government policies are considered exogenous. Therefore, the supply-side decisions in this economy remain independent of the demand-side decisions. The composition of outputs produced in the economy do not depend on the composition of domestic demand. The production decisions are guided by the principles of profit maximisation. To simplify further, it is assumed that all domestic users of the commodities maximise identical Cobb-Douglas utility functions and ignore the consequence of income-distributional changes operating through commodity demand. The representative consumer receives all national income (value-added and tariff revenue) and spends it on the consumption of the two commodities. Finally, to complete the description of the economic sphere of the political economy, the net inflow of capital to the home country is assumed to be zero. This forces the trade account, in equilibrium, to balance at foreign prices.

| Table 1 | A stylised tariff (policy) endogenous general equilibrium model of a small open economy (PEGEM) |
|---|---|

<u>The Economic Market (or Sphere)</u>

(a)The Goods Market:
*The supply functions of domestic production sectors*:

$$(1) \qquad Y_j = K_j \beta_j^{-1/\rho_j} \left[ 1 - \alpha_j^{1/(1+\rho_j)} \left( W/P_j \right)^{\rho_j/(1+\rho_j)} \right]^{1/\rho_j}, \qquad\qquad j=1,2.$$

*Consumer demand functions*:

$$(2) \qquad C_j = \left( \delta_j / P_j \right) \left[ \sum_{i=1}^{2} P_i Y_i + T_1^R P_1^* M_1 \right], \qquad\qquad j=1,2.$$

*Equilibrium in the market of good 1.*

$$(3) \qquad C_1 = Y_1 + M_1$$

(b)The Foreign Exchange Market:
*Trade balance constraint*:

$$(4) \qquad P_1^* M_1 + P_2^* M_2 = 0.$$

(c)The Labour Market:
*Sectoral labour demand*:

$$(5) \qquad L_j = K_j \alpha_j^{1/(1+\rho_j)} \beta_j^{-1/\rho_j} \left[ \left( P_j/W \right)^{\rho_j/(1+\rho_j)} - \alpha_j^{1/(1+\rho_j)} \right]^{1/\rho_j}, \qquad j=1,2.$$

*Labour market equilibrium*:

$$(6) \qquad L = \sum_{j=1}^{2} L_j$$

*Domestic price determination*:

$$(7) \qquad P_1 = P_1^* \left( 1 + T_1^R \right)$$

*Virtual rental rates*:

$$(8) \qquad R_j = \beta_j^{-1/\rho_j} \left( P_j^{\rho_j/(1+\rho_j)} - \alpha_j^{1/(1+\rho_j)} W^{\rho_j/(1+\rho_j)} \right)^{(1+\rho_j)/\rho_j}, \qquad\qquad j=1,2.$$

The Political Market (or Sphere)
*Condition for bargaining equilibrium:*

(15)    $$\frac{\Pi_1 - \Pi_1^d}{\Pi_2 - \Pi_2^d} = \frac{\Theta_1}{\Theta_2} \frac{\Pi_1}{\Pi_2} \left( \frac{\sigma_2 Y_2}{\sigma_1 Y_1 P_1} \right).$$

Definition:

(10)      $\Pi_i = K_i R_i / P_i$,                                    $i$=1,2.

**Total number of equations 15.**

List of Endogenous Variables:

| | | |
|---|---|---|
| $\Pi_j$ | $j$=1,2. | : 2 Sectoral rental incomes |
| $Y_j$ | $j$=1,2. | : 2 Sectoral outputs |
| $C_j$ | $j$=1,2. | : 2 Domestic demands |
| $M_j$ | $j$=1,2. | : 2 Net Import quantities |
| $L_j$ | $j$=1,2. | : 2 Sectoral employment of labour |
| $R_j$ | $j$=1,2. | : 2 Sectoral rental rates in units of commodity 2 |
| $W$ | | : 1 Wage rate in units of commodity 2 |
| $P_1$ | | : 1 Price of commodity 1 in units of commodity 2 |
| $T_1^R$ | | : 1 Rationalised tariff rate |

**Total number of endogenous variables: 15.**

List of exogenous variables:

| | | |
|---|---|---|
| $K_j$ | $j$=1,2. | : 2 Endowments of sector specific capital stocks |
| $L$ | | : 1 Endowment of Labour in the economy |
| $P_1^*$ | | : 1 International relative price of commodity 1 |
| $\Pi_j^d$ | $j$=1,2. | : 2 Disagreement payoffs |
| $P_2$ | | : Price of the numeraire commodity (always unity). |

**Total number of exogenous variables: 7.**

Parameters:

| | | |
|---|---|---|
| $\sigma_j = 1/(1+\rho_j)$ | $j$=1,2. | : 2 Elasticities of factor substitution |
| $\alpha_j, \beta_j$ | $j$=1,2. | : 4 Distributive parameters of CES production functions |
| $\delta_j$ | $j$=1,2. | : 2 Budget share parameter of C-D utility function |
| $\Theta_1, \Theta_2$ | | : 2 Parameters reflecting the bargaining powers |

**Total number of parameters: 8.**

**Source:** Author's own calculations

Given international prices, the tariff rate and hence the domestic prices, the above assumptions on the economic sphere lead to a set of conditions which are listed in Table 1, characterising an equilibrium in the economic sphere of the political economy. Equations (5) and (6) describe a fully flexible labour market, which determines sectoral allocation of labour and an equilibrium wage rate for given commodity prices and factor endowment. Equation (1) then yields sectoral output supply at these prices and equation (2) yields domestic consumption of the two commodities. Equations (3) and (4) yield the quantities of net imports of the two commodities which are two of the three market clearing conditions for two commodities and one foreign exchange. Invoking Walras law, the market clearing condition for commodity 2 has been omitted. Equation (8) yields the rental rates at which the employment of the existing stocks of sector-specific capital are optimal to produce the optimal output levels at given commodity prices and the resulting equilibrium wage rate. Using the homogeneity property of the model, the nominal exchange rate has been set to unity and commodity 2 has been treated as the numeraire. It must be noted that these normalisations have no consequence on the employment and on the allocation of the commodities in the economy. Details of the derivation of these results can be found in Pant (1992).

## The rent transformation function

**Definition 1** (*Rent Transformation Frontier*)   The locus of the combinations of equilibrium rental incomes (or rates) in units of own output corresponding to each tariff rate (or domestic relative price) is defined as the Rent Transformation Frontier (RTF). A function that describes the locus is the Rent Transformation Function.

By eliminating the wage rate variable from the two sectoral-rental functions given by equation (8) the rent transformation function can be expressed as

$$
(9) \qquad \Pi_1 = K_1 P_1^{-1} \beta_1^{\frac{-\sigma_1}{1-\sigma_1}} \left[ P_1^{1-\sigma_1} - \alpha_1^{\sigma_1} \alpha_2^{1-\sigma_2} \left( 1 - \beta_2^{\sigma_2} \left( \frac{\Pi_2}{K_2} \right)^{1-\sigma_2} \right)^{\frac{1-\sigma_1}{1-\sigma_2}} \right]^{\frac{1}{1-\sigma_1}}
$$

where,

$$
(10) \qquad \Pi_i = K_i R_i / P_i \quad \text{for each } i = 1, 2
$$

is the normalised (in units of own output) profit or rental income to the owner of the specific factor employed in sector $i$. This concept of rent transformation

frontier is analogous to Gardner's concept of surplus transformation frontier (Gardner 1983). It has been shown elsewhere (Pant 1992) that

$$d\prod_1 / d\prod_2 < 0,$$

and sufficient conditions for $d^2\prod_1 / d\prod_2^2 < 0$ are that $\sigma_i \geq 1$ for $i = 1, 2$.

Thus, if the elasticities of factor substitution are at least unity, then the rent transformation frontier slopes downward to the right and is concave to the origin in the rental-plane, as shown in Figure 1. In what follows, it is assumed that $\sigma_i \geq 1$ for $i = 1, 2$.

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Figure 1    Price changes: movements along the RTF
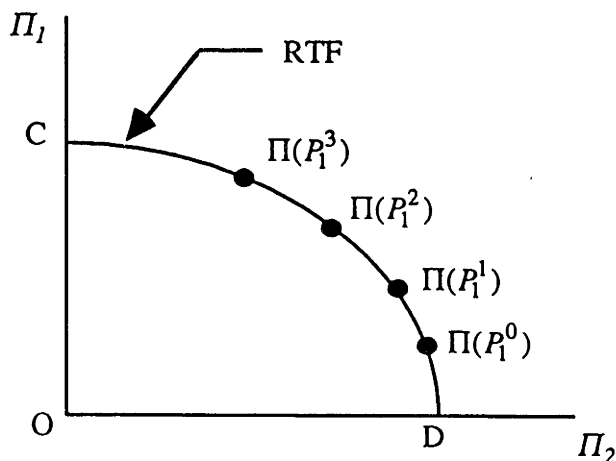


Source: Author's own calculations

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The rent transformation frontier (or function) is a useful device to understand how a change in domestic relative price effects a transfer of rents in equilibrium between the owners of capital in the two sectors. It is well known that as the relative price of the import-competing good increases, the real rental income in sector 1 increases and the real rental income in sector 2 falls (see, for example, Neary 1978).

## The political sphere of a stylised political economy and the bargaining problem

The RTF is sufficient to indicate that any change in the government's tariff policy induces a transfer of real rents from the owners of the specific factor in one sector to the owners of the specific factor in the other. Given that the owners of the specific factors wish to maximise their real rental income, it is rational for them to spend real resources in influencing the policy decisions of the government. Following previous studies (for example, Long and Vousden 1991), it is assumed that the government is a political-support maximiser or opposition minimiser.[1] It is further assumed that the owners of the mobile factor are large in number and are rationally ignorant of the possible impacts of a small change in the government's policies. Moreover, they have sufficiently high organisational costs (and free rider problem) to deter them from behaving strategically *vis à vis* the government and other factor owners. However, their individual political behaviour can be influenced by the lobbying activities (political education) of the other strategic agents, namely the owners of the specific factors. The government and the owners of the two specific factors are assumed to be organised and fully informed of both the political responses of the non-strategic agents to their lobbying efforts and the responses of the economic sphere to policy changes.

Under the above assumptions, the political support or opposition to the government depends on the lobbying behaviour of the specific-factor owners and the rental incomes of the specific-factor owners depend on the government's choice of the tariff rate. Thus, there is a gaming situation among the owners of the two specific factors and the government. What a player obtains at the end depends not only on its actions but also on the actions of the rest of the players. As a support maximiser, the government will choose a tariff rate so as to minimise political opposition and the two owners of sector specific factors will limit their lobbying efforts (political activities) so as to maximise their real rental incomes. It is further assumed that the political process allows the players to communicate their threats, bluffs, proposals and counter-proposals and finally enter into a binding agreement if it is individually rational to do so.

Given such a political environment, it is clear that if the two owners of the specific factors agree on a particular tariff rate, then the best policy for the government is to implement it. This will guarantee maximum support to the

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[1] See Baldwin (1987) for analytical similarity between the choices of a support-maximising government and a welfare-maximising government.

government and the two specific-factor owners will receive the resulting rental income as their payoffs. In the event of disagreement however, the government is assumed to behave as a Stackelberg leader *vis-à-vis* the two private players. The government announces a lobbying sensitive policy (tariff) function in order to extract maximum political support and the two players behave as Nash players against each other taking the government's policy function as given. The tariff rate that emerges at the Nash equilibrium of the non-cooperative game will be implemented. The owners of the specific factors will receive the resulting rents less the lobbying expenditures as their payoffs.

However, had the two players been able to negotiate and agree on some price, say, and had agreed not to participate in competitive lobbying, both would have received payoffs represented by a corresponding point at the frontier, such as point R, (see Figure 2) which represents a combinations of higher payoffs than that corresponding to point E.

Figure 2   Payoffs in cooperation/non-cooperation
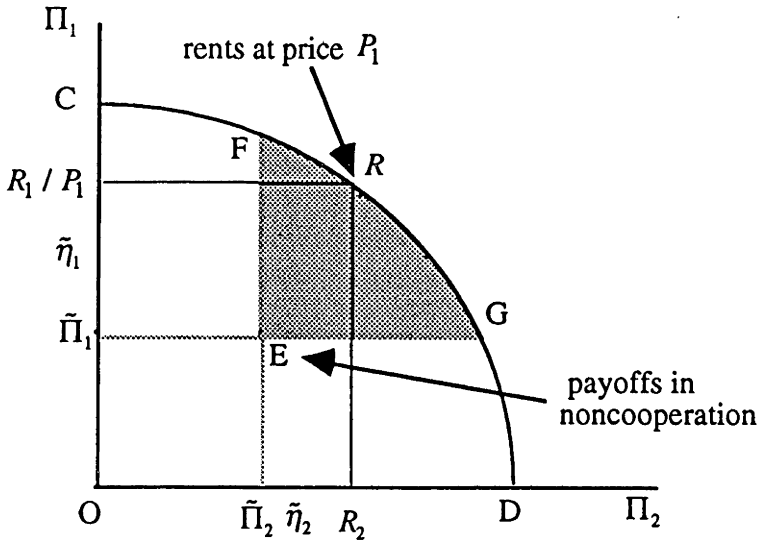


Source: Author's own calculations

There are three reasons to believe that all agreements reached in a tariff game will be enforceable. First, playing a non-cooperative Nash equilibrium strategy is always a credible threat that can be issued by any player against the other player and that works as a deterrent against possible deviant behaviour by either player.

Second, as Subik (1982) argued, constitutional arrangements and the presence of the government as the enforcing agency makes players almost incapable of deviating from any agreement. Moreover, if the government is a support maximiser, as has been assumed, then it will also have an incentive to implement such cooperative agreements. Third, the tariff game can be viewed as a periodic game played repeatedly. Cooperative outcomes of repeated games are, in general, self-enforcing (Fudenberg and Maskin 1986; Friedman 1986). Thus, a bargain-theoretic approach appears a natural way to study the equilibrating process in the political sphere of a political economy.

**Definition 2** (*Bargaining Set*).   For given disagreement payoffs $\prod^d \equiv \left(\prod_1^d, \prod_2^d\right)$, let

$$\mathfrak{R} = \Bigl\{ \left(\prod{}_1, \prod{}_2\right) \big/ \prod{}_1 \leq K_1 P_1^{-1}\beta_1^{-\sigma_1/(1-\sigma_1)} \times$$

$$\left[ P_1^{1-\sigma_1} - \alpha_1^{\sigma_1}\alpha_2^{-\sigma_2(1-\sigma_1)/(1-\sigma_2)} \left(1 - \beta_2^{\sigma_2}\left(\prod{}_2/K_2\right)^{1-\sigma_2}\right)^{(1-\sigma_1)/(1-\sigma_2)} \right]^{1/(1-\sigma_1)} ; \prod{}_i \geq \prod{}_i^d \Bigr\}$$

then $\mathfrak{R}$ is a collection of all payoff combinations that are individually rational. $\mathfrak{R}$ is defined as the bargaining set over which the players in the tariff game may bargain. The pair $\left(\mathfrak{R}, \prod^d\right)$ defines a bargaining problem in a tariff-setting game.

Note that the Pareto efficient boundary of the bargaining set is the segment which contains individually rational points of the rent transformation frontier (see equation 9). Therefore, under the assumption that the elasticities of factor substitution are at least unity, the set $\mathfrak{R}$ is convex. Since the maximum output that a sector can produce in the event of specialisation is finite (because of finite endowment factor(s) and a concave production function), and since the rental income is always less than the level of output, the set $\mathfrak{R}$ is also bounded. That is, the set $\mathfrak{R}$ includes its boundary points, hence it is closed and the set $\mathfrak{R}$ is also a subset of a 2-dimensional Euclidean space, therefore it is compact and convex. Any concave function defined over $\mathfrak{R}$ will have its maximum in it.

Given that the disagreement payoff, $\prod^d$, is predetermined, the underlying bargaining problem of the tariff game satisfies the conditions of the existence theorem proved by Nash (1953). Where the disagreement payoff is not known a priori, the bargaining problem in a tariff game satisfies the conditions of the existence theorem proved in Harsanyi (1963). Thus, whether the disagreement

payoffs are assumed to be predetermined or not (that is variable), the bargaining problem $\left(\Re, \prod{}^{d}\right)$ admits a unique Nash solution (Nash 1953).[2]

## Nash solution to the bargaining problem in a tariff game

Nash's original solution to a bargaining problem, however, was based on the contention that all significant differences between the players can be captured by the differences in the bargaining set and the disagreement payoffs. Subsequent authors have shown several sources of asymmetry in the bargaining powers among the players that are not accounted for by the bargaining set and the disagreement point—the constituents of a mathematical description of a bargaining problem. For example, Kalai (1977) has shown that if an n-person symmetric bargaining game is played by two coalitions of size p and q, with p+q=n such that within each coalition players have identical utility functions, then a non-symmetric Nash solution may arise even if the n-person game yields a symmetric Nash solution. In this case the source of apparent 'bargaining power' of the coalition is its membership. This was not envisaged by Nash. Similarly, the other sources of asymmetry are: players having different degrees of risk aversion (Roth, 1979); difference in the time preference rate (Rubinstein, 1982); different probability attached to the risk of breakdown of the negotiation (Binmore, Rubinstein, and Wolinsky, 1986), bargaining skill (Ohyama, 1989) and players possessing imperfect knowledge about each other (Harsanyi and Selton, 1972).[3] In particular, these studies contend that players may well be endowed with uneven bargaining powers or weights.

A generalised Nash solution to a bargaining problem is obtained by Roth (1979), which allows players to differ in their relative bargaining power for whatever reasons. Therefore, a Nash solution to the bargaining problem in the tariff game is obtained as a solution to the following maximisation problem:

(11)    $\max\left[\prod_{1}-\prod_{1}^{d}\right]^{\theta_{1}}\left[\prod_{2}-\prod_{2}^{d}\right]^{\theta_{2}},$

---

[2] For the robustness of Nash solution with respect to various perturbations to its assumptions see Carlson (1991).

[3] Further references of the works that have independently obtained asymmetric Nash bargaining solutions can be found in Binmore (1987:94).

subject to the RTF,

$$(12) \quad \prod_1 \leq K_1 P_1^{-1} \beta_1^{\frac{-\sigma_1}{1-\sigma_1}} \left[ P_1^{1-\sigma_1} - \alpha_1^{\sigma_1} \alpha_2^{-\frac{\sigma_2(1-\sigma_1)}{1-\sigma_2}} \left( 1 - \beta_2^{\sigma_2} \left( \frac{\prod_2}{K_2} \right)^{1-\sigma_2} \right)^{\frac{1-\sigma_1}{1-\sigma_2}} \right]^{\frac{1}{1-\sigma_1}} ;$$

and that $\prod_i \geq \prod_i^d$ for each player $i=1, 2$.

where, $\Theta_1$ and $\Theta_2$ measure the bargaining power of the two players such that $\Theta_1 + \Theta_2 = 1$.

Since the bargaining set is compact and convex and the maximand (the generalised Nash product) is concave over the bargaining set, the necessary and sufficient condition for the generalised Nash solution to the bargaining problem in the tariff game can be written as

$$(13) \quad \frac{\prod_1 - \prod_1^d}{\prod_2 - \prod_2^d} = -\frac{\Theta_1}{\Theta_2} \frac{d\prod_1}{d\prod_2}\bigg|_{RTF}$$

It has been shown elsewhere (Pant 1992) that

$$(14a) \quad \frac{d\prod_1}{d\prod_2}\bigg|_{RTF} = -\frac{\prod_1}{\prod_2} \left( \frac{\sigma_2 Y_2}{\sigma_1 Y_1 P_1} \right)$$

which can also be expressed as

$$(14b) \quad \frac{d\prod_1}{d\prod_2}\bigg|_{RTF} = -\frac{\sigma_2 S_{K1}}{\sigma_1 S_{K2} P_1}$$

where $S_{Ki} = \prod_i / Y_i$ is the distributive share of capital in sectoral output in each sector $i$.

Now substituting the expression for the slope of the RTF from equation (14a) into equation (13) results in

$$(15) \quad \frac{\prod_1 - \prod_1^d}{\prod_2 - \prod_2^d} = \frac{\Theta_1}{\Theta_2} \frac{\prod_1}{\prod_2} \left( \frac{\sigma_2 Y_2}{\sigma_1 Y_1 P_1} \right)$$

Alternately, equation (15) may also be written as

$$(16) \quad \frac{\prod_1 - \prod_1^d}{\prod_2 - \prod_2^d} = \frac{\Theta_1}{\Theta_2} \left( \frac{\sigma_2 S_{K1}}{\sigma_1 S_{K2} P_1} \right)$$

Condition (16) can be explained as follows. Since $\prod_1$ is a strictly increasing function of $P_1$, and $\prod_2$ is a strictly decreasing function of $P_1$, the left-hand side of equation (16) is a strictly increasing function of $P_1$ for given a value of $\prod^d$. Given that $\sigma_i \geq 1$ and $\sigma_2 \geq 1$, it is also known that $S_{K1}$ is a non-increasing function of $P_1$, and $S_{K2}$ is a non-decreasing (constant in the Cobb-Douglas case) function of $P_1$. Therefore, for a given distribution of bargaining power, the right-hand side of equation (16) is a strictly decreasing function of $P_1$. Thus, a unique domestic relative price satisfies the necessary and sufficient condition for the solution to the bargaining problem. The existence problem is solved, however, by the compact and convex nature of the bargaining set and concavity of the maximand-generalised Nash product.

It is interesting to note that the condition (13), first expounded by Aumann and Kurz (1977a) and subsequently refined by Roth (1979) and Svejnar (1986), implies an equality of players' fear of ruin relative to their bargaining power at the point of Nash solution. A player's fear of ruin is the inverse of the maximum probability of disagreement (ruin) per unit of additional gain which the player is prepared to tolerate for a very small potential gain. Thus, condition (13) not only identifies the Nash solution to a bargaining problem but also provides an intuitive explanation of why such a solution is obtained. This condition forcefully puts forward Zuthen's (1930) explanation that during a bargaining process the player who fears most concedes.

In the case of a tariff game where the players bargain over the magnitude of the relative price of commodity 1, Pant (1992) has shown that player 1's fear of ruin, $f_1$, is given by

$$(17a) \quad f_1(P_1) = \frac{\prod_1(P_1) - \prod_1^d}{d\prod_1 / dP_1},$$

and player 2's fear of ruin, $f_2$, is given by

$$(17b) \quad f_2(P_1) = \frac{\prod_2(P_1) - \prod_2^d}{d\prod_2 / dP_1}$$

It can now be seen from condition (13) that at the point of Nash solution to the bargaining problem, we have $f_1/\Theta_1 = f_2/\Theta_2$. That is, the players' fear of ruin relative to their bargaining power are equalised. Any shock that displaces the system out of equilibrium makes either one of the players more fearful of ruin and induces it to concede. The process continues until a new solution is found.

Thus, equation (15) describes the equilibrating mechanism in the political sphere and RTF provides the interface between the economic and the political spheres. Therefore, equation (15) together with the conditions of general equilibrium of the economic sphere yield the conditions of general equilibrium of the political economy. The system of equations describing the general equilibrium of the political economy are listed in Table 1. This describes a system of 15 equations in 15 endogenous variables, including the rationalised tariff rate. For given values of exogenous variables and model parameters, the system, in principle, can be solved for the 15 endogenous variables. The solution vector of endogenous variables describes the general equilibrium of the political-economic system of the stylised economy. The tariff rate that emerges at the equilibrium of the political economy is the bargained tariff rate.

This system demands more information than that given by a conventional policy-exogenous CGE model. In addition to the information required by a conventional CGE model, it requires information on the distribution of the players' bargaining powers and disagreement payoffs. With respect to the bargaining powers, the assumption is made that the distribution of bargaining power between the players is exogenously given and it is unaffected by small changes in the values of exogenous variables.

## Identification of the disagreement payoffs and the players' minimum expectations

The disagreement payoff is the payoff that players will receive in the event that they fail to reach an agreement. A natural candidate for this is the payoffs at a non-cooperative Nash equilibrium in the tariff game. However, there are two problems which make the use of payoffs at a non-cooperative Nash equilibrium less attractive. First, the possibility of multiple Nash equilibria cannot be dismissed a priori and there seems no clear way of identifying which one of them will be attained in the event of a disagreement. Second, even if there are reasons to believe that a unique Nash equilibrium will be attained, the government's pricing function has to be specified before any Nash equilibrium can be computed. This would further require knowledge of the government's political support function.

In general, the operational definition of the disagreement payoffs in the theory of bargaining has remained unclear. Identification of the disagreement payoffs has therefore been suggested as a matter of modelling judgement (Binmore, Rubinstein, and Wolinsky 1986). The concept of minimum expectation as

proposed by Roth (1977) is well defined and operational. Thomson (1981) has shown that the payoffs at minimum expectation possess some desirable properties of a reference point to the players involved in a bargaining process. Thus, the payoffs at the point of minimum expectation appear to be quite reasonable in operationalising the concept of disagreement payoffs in solving bargaining problems. Roth's concept of minimum expectation can be defined in the following way.

**Definition 3** (*minimum expectation*) Let $\overline{\mathfrak{R}}$ be the set of all feasible payoff combinations. For each player $i$, let

$$\prod_i^{max} = \max\left\{\prod_i \Big| (\prod_i, \prod_{-i}) \in \overline{\mathfrak{R}}\right\}; \qquad \text{and}$$

$$\prod_i^{min} = \max\left\{\prod_i \Big| (\prod_i, \prod_{-1}^{max}) \in \overline{\mathfrak{R}}\right\}$$

Then the payoff combination $\prod^{min} \equiv (\prod_1^{min}, \prod_2^{min})$ is a combination of the minimum expectations of the players and the payoff combination $\prod^{max} \equiv (\prod_1^{max}, \prod_2^{max})$, also called the ideal point, is a combination of the aspiration levels of the players (see Figure 3)[4].

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Figure 3 **The point of minimum expectation**



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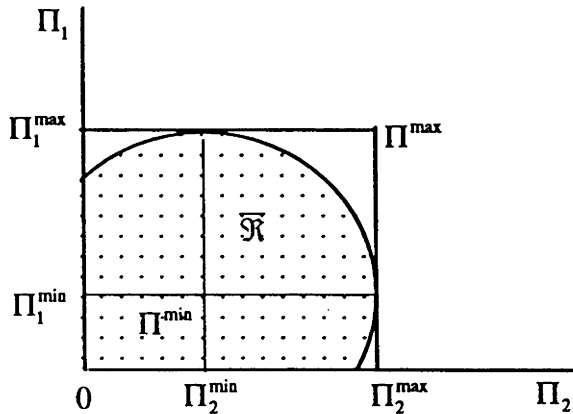
Source: Author's own calculations

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[4]See also Friedman 1986:160-2.

---

One attractive feature of the point of minimum expectation is that it represents the payoff to each player when the bargaining opponent has been able to obtain the best possible outcome for itself, say by forming a coalition with the government or by pre-emptive lobbying. The payoff combination $\prod^{min}$ therefore represents the worst outcome for each player. No rational player will choose a strategy that yields its opponent a payoff less than that corresponding to $\prod^{min}$ because such strategy would bring no benefit and possibly would lead to a reduction in its own payoff. In other words, for each player, the payoff combination corresponds to the opponent's dictatorial solution.

Roth (1977) has shown that the Nash solution to the class of bargaining problems in which the disagreement payoff is given satisfies all the axioms as satisfied by the original Nash solution. The only difference between the two is that Nash's solution is independent of irrelevant alternatives (axiom of independence) other than the disagreement point, whereas the new solution will be independent of irrelevant alternatives other than the point of minimum expectation.

## Minimum expectation in the tariff game

Minimum expectation payoffs of the two players under two different political environments are derived. First, a special case is considered where the government may rule by force. The possibility is allowed that any one of the players may form a coalition with the government which chooses a policy that best suits the winning player. The government balances its budget, if necessary, by taxing the losing player and other non-strategic agents in the economy. This type of situation is called unconstrained government behaviour. In this case, if a player fails to form a coalition with the government, the worst outcome to the player could be that it has to surrender all of its rental income to finance the government's budget deficit created by the price policy favouring the opponent. This, in turn, with unconstrained government behaviour, implies that the payoff at the minimum expectation of each player is zero. Therefore,

$$\prod{}^{min} = (0,0)$$

Next, a case with constrained government behaviour is considered in which the government, in the event of disagreement among the private players, offers a lobbying-sensitive tariff (pricing) function such that any equilibrium price that emerges is self-financing. In particular, this assumption implies that the range of the government's pricing function is bounded between the free trade price and the autarkic price. This, in turn, implies that the aspiration level of player 1 is

obtained when the price takes its upper bound, that is the autarkic price, and the aspiration level of player 2 is obtained when the price takes its lower bound, that is the free trade price. Thus, player 1's (import-competing sector) minimum expectation is the payoff at the free trade price and player 2's (exporting sector) minimum expectation is the payoff at the autarkic price (see Figure 4). Therefore, under constrained government behaviour,

$$\Pi^{\min} = \left( \Pi_1^*, \Pi_2^a \right)$$

where $\Pi_1^*$ is the rental income of the import-competing sector at the free trade price, and $\Pi_2^a$ is the rental income of the exporting sector at the autarky price.

Clearly, as the RTF shifts with a change in factor endowment, so do the payoffs at these two prices. Therefore, $\Pi^{\min} = \left( \Pi_1^*, \Pi_2^a \right)$ is sensitive to changes in the boundary of the feasible set. This is a property which is not possessed by $\Pi_d = \Pi^{\min} = (0,0)$. Moreover, $\Pi^{\min} = \left( \Pi_1^*, \Pi_2^a \right)$ also satisfies Thomson's other two desirable properties of a reference point.[5] Therefore, in a more general case, $\Pi^{\min} = \left( \Pi_1^*, \Pi_2^a \right)$ is used as the reference point of the players for the bargaining problem in a tariff game.

Figure 4    Minimum expectation under constrained government behaviour
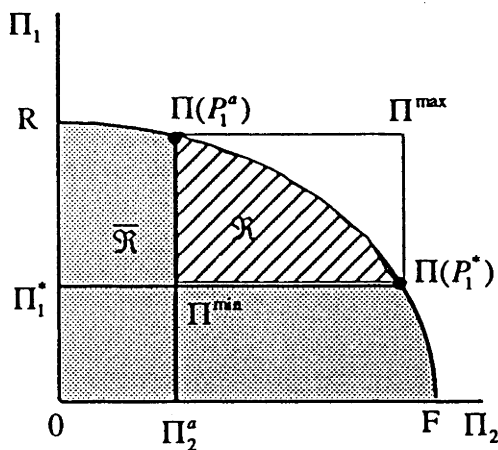
[5]See Pant (1992) for a discussion on the properties satisfied by the point of minimum expectation defined by $\Pi^{\min} = \left( \Pi_1^*, \Pi_2^a \right)$.

However, the case with $\pi^d = \pi^{\min} = (0,0)$ is interesting for three reasons. First, it greatly simplifies the model so that analytical results are possible. It can also be used to illustrate the mechanism of endogenous determination of the tariff rate. Second, it corresponds to a potentially dictatorial type of government. The results, therefore, will show the behaviour of bargained tariff rates under a particular political environment where the government can be captured by one of the bargaining party if no agreement is reached during the bargaining process. Third, more interestingly, $\prod_d = 0$ corresponds to Magee, Brock, and Young's economic black hole[6] and could be considered as the worst possible non-cooperative Nash equilibrium outcome in the tariff game. So the analysis begins with the comparative static experiments with this special case and proceeds onto the general case.

## Comparative static behaviour of the endogenous tariff rate: unconstrained government behaviour

### Modification of the model

In this section, a version of the PEGEM is derived that is applicable under unconstrained government behaviour. It is known that under unconstrained government behaviour the minimum expectation of the players is the origin. Therefore, substituting into equation (15) and solving for $P_1$

$$(18) \qquad P_1 = \left( \frac{\Theta_1 \sigma_2}{\Theta_2 \sigma_1} \right) \frac{Y_2}{Y_1}$$

Linearising equation (18) around the 'observed' general equilibrium point gives

$$(19) \qquad p_1^\circ = (\theta_1 - \theta_2) + (y_2^\circ - y_1^\circ)$$

At unchanged bargaining powers, whatever they may be, equation (19) reduces to

$$(20) \qquad p_1^\circ = (y_2^\circ - y_1^\circ)$$

---

[6]Magee, Brock and Young (1989:223) have defined an economic black hole, in the context of a long-run model in which both capital and labour are involved in predatory lobbying, as a situation in which all of the economy's factor endowment is exhausted in predatory lobbying. A short-run is a situation in which only the owners of the specific factors exhaust all of their rental incomes in predatory lobbying. So, if in a non cooperative Nash equilibrium each player exhausts its rents in predatory lobbying and obtains zero payoffs, then the equilibrium tariff thus determined may be defined as the black hole tariff.

Equation (20) shows that if some exogenous shock led the outputs of the two sectors in the new equilibrium to grow at different rates, then the relative price of the commodity growing at a faster rate will fall. In order to get a more precise meaning from equation (20), the rest of the equations listed in Table 1 are linearised to obtain the linearised version of the PEGEM that is listed in Table 2. Four equations are omitted, equations (10), (2), (3),and (4), which are of no consequence to the following analysis. Note that the equations (21) - (26) are the linearised versions of the equations (1), (5), (6), (7) and (8) respectively. As a notational convention, superscript 'o', 'a' and '*' indicate respectively that the shares or the variable has been defined around the observed (base year), autarkic or free trade equilibrium; and lower case has been used to denote variables in percentage change and upper case is used to denote the corresponding variables in levels.

---

Table 2    Linearised version of PEGEM: unconstrained government
           behaviour

---

The Political Sphere:

(19')    $p_1^{\circ} = \left( y_2^{\circ} - y_1^{\circ} \right).$

The Economic Sphere:
*The supply functions:*

(21)    $y_j^{\circ} = k_j + \sigma_j \left( \dfrac{S_{Lj}^{\circ}}{S_{Kj}^{\circ}} \right) \left( p_j^{\circ} - w^{\circ} \right)$          $j=1,2.$

*Labour demands functions:*

(22)    $l_j^{\circ} = k_j + \dfrac{\sigma_j}{S_{Kj}^{\circ}} \left( p_j^{\circ} - w^{\circ} \right)$          $j=1,2.$

*The labour market equilibrium condition:*

(23)    $l = \displaystyle\sum_{j=1}^{2} \lambda_j^{\circ} l_j^{\circ}$

*Price equations:*

(24)    $p_1^{\circ} = p_1^{*} + \tau^{\circ} t$ and $p_2^{\circ} = 0$

*Sectoral rental rates:*

(25)    $r_j^{\circ} = \dfrac{1}{S_{Kj}^{\circ}} \left( p_j^{\circ} - S_{Lj}^{\circ} w^{\circ} \right).$          $j=1,2.$

---

Source: Author's own calculations

---

The system of equations listed in Table 2 contains nine equations in nine endogenous variables, including the tariff rate. The system can be solved and the elasticity formulae can be obtained for each of the endogenous variables with respect to each of the exogenous variables.

## Comparative static responses of the tariff rate

First equations (22) and (23) are solved for changes in the wage rate and its response with respect to the exogenous variables—factor endowment and commodity prices. Then, this result is used in equation (21) to obtain

$$
(26) \quad y_2^\circ - y_1^\circ = \frac{1}{A^\circ}\left[\left(\frac{\lambda_1^\circ \sigma_1}{S_{K1}^\circ} + \frac{\lambda_2^\circ \sigma_1 S_{L1}^\circ}{S_{K1}^\circ} + \lambda_2^\circ \sigma_2\right)k_2 - \left(\frac{\lambda_2^\circ \sigma_2}{S_{K2}^\circ} + \frac{\lambda_1^\circ \sigma_2 S_{L2}^\circ}{S_{K1}^\circ} + \lambda_1^\circ \sigma_1\right)k_1\right.
$$

$$
\left. - \left(\frac{\sigma_2 S_{L2}^\circ}{S_{K2}^\circ}\frac{\lambda_1^\circ \sigma_1}{S_{K1}^\circ} + \frac{\sigma_1 S_{L1}^\circ}{S_{K1}^\circ}\frac{\lambda_2^\circ \sigma_2}{S_{K2}^\circ}\right)p_1 + \left(\frac{\sigma_2 S_{L2}^\circ}{S_{K2}^\circ} - \frac{\sigma_1 S_{L1}^\circ}{S_{K1}^\circ}\right)l\right]
$$

where $\quad A^\circ = \lambda_1^\circ \sigma_1 / S_{K1}^\circ + \lambda_2^\circ \sigma_2 / S_{K2}^\circ > 0$

Solving equation (20), and (21) for $p_1^\circ$

$$
(27) \quad p_1^\circ = B^{-1}\left[\left(\frac{\lambda_1^\circ \sigma_1}{S_{K1}^\circ} + \frac{\lambda_2^\circ \sigma_1 S_{L1}^\circ}{S_{K1}^\circ} + \lambda_2^\circ \sigma_2\right)k_2 - \left(\frac{\lambda_2^\circ \sigma_2}{S_{K2}^\circ} + \frac{\lambda_1^\circ \sigma_2 S_{L2}^\circ}{S_{K1}^\circ 2} + \lambda_1^\circ \sigma_1\right)k_1\right.
$$

$$
\left. + \left(\frac{\sigma_2 S_{L2}^\circ}{S_{K2}^\circ} - \frac{\sigma_1 S_{L1}^\circ}{S_{K1}^\circ}\right)l\right]
$$

where $\quad B = A^\circ + \left(\frac{\sigma_2 S_{L2}^\circ}{S_{K2}^\circ}\frac{\lambda_1^\circ \sigma_1}{S_{K1}^\circ} + \frac{\sigma_1 S_{L1}^\circ}{S_{K1}^\circ}\frac{\lambda_2^\circ \sigma_2}{S_{K2}^\circ}\right) > 0$

Recalling that the factor creating a wedge between the domestic relative price and the world relative price is the tariff rate(see equation (24) in Table 3) it follows from equation (27) that

$$
(28) \quad \tau t = -p_1^* + B^{-1}\left[\left(\frac{\lambda_1^\circ \sigma_1}{S_{K1}^\circ} + \frac{\lambda_2^\circ \sigma_1 S_{L1}^\circ}{S_{K1}^\circ} + \lambda_2^\circ \sigma_2\right)k_2\right.
$$

$$
\left. - \left(\frac{\lambda_2^\circ \sigma_2}{S_{K2}^\circ} + \frac{\lambda_1^\circ \sigma_2 S_{L2}^\circ}{S_{K1}^\circ 2} + \lambda_1^\circ \sigma_1\right)k_1 + \left(\frac{\sigma_2 S_{L2}^\circ}{S_{K2}^\circ} - \frac{\sigma_1 S_{L1}^\circ}{S_{K1}^\circ}\right)l\right]
$$

Some interesting results follow from equation (28). Before discussing these , recall the definitions of the variables and parameters involved in the equations. First, $\tau = 1/(1 + T_1^R)$, where $T_1^R$ is the rationalised tariff rate and $t = 100 \times dT_1^R$ is the change in the percentage point (not the percentage change in the tariff rate) of the rationalised tariff rate. The term $(1 + T_1^R)$ can be viewed as the rate of protection offered to the import-competing sector and therefore the term $\tau t$, which represents the percentage change in $(1 + T_1^R)$, can also be viewed as the percentage change in the rate of protection awarded to the import-competing sector. If, in the initial full equilibrium $T_1^R > 0$, that is, the economy was taxing trade, then $0 < \tau < 1$. Similarly, $\tau = 1$ for $T_1^R = 0$, and $\tau > 1$ for $-1 < T_1^R < 0$. Excluding the possibility of subsidising imports or taxing exports at rates greater than 100 per cent as practically implausible, then the parameter $\tau$ is always positive. Furthermore, the share parameters $\lambda_1, \lambda_2, S_{K1}, S_{K2}, S_{L1}$ and $S_{L2}$ are always positive, as are the elasticities of factor substitution $\sigma_1$ and $\sigma_2$.

By setting any three of the four exogenous variables, $p_1^*, k_1, k_2$, and $l$, equal to zero in turn, the comparative static response of the tariff rate is as follows:

(29) $\quad \dfrac{\tau t}{p_1^*} = -1 < 0;$

(30) $\quad \dfrac{\tau t}{k_1} = -B^{-1}\left( \dfrac{\lambda_2^{\circ}\sigma_2}{S_{K2}^{\circ}} + \dfrac{\lambda_1^{\circ}\sigma_2 S_{L2}^{\circ}}{S_{K2}^{\circ}} + \lambda_1^{\circ}\sigma_1 \right) < 0$

(31) $\quad \dfrac{\tau t}{k_2} = B^{-1}\left( \dfrac{\lambda_1^{\circ}\sigma_1}{S_{K1}^{\circ}} + \dfrac{\lambda_2^{\circ}\sigma_1 S_{L1}^{\circ}}{S_{K1}^{\circ}} + \lambda_2^{\circ}\sigma_2 \right) > 0$ and

(32) $\quad \dfrac{\tau t}{l} = B^{-1}\left( \dfrac{\sigma_2 S_{L2}^{\circ}}{S_{K2}^{\circ}} - \dfrac{\sigma_1 S_{L1}^{\circ}}{S_{K1}^{\circ}} \right) \gtrless 0$ as $\dfrac{\sigma_2 S_{L2}^{\circ}}{S_{K2}^{\circ}} \gtrless \dfrac{\sigma_1 S_{L1}^{\circ}}{S_{K1}^{\circ}}.$

For small changes, other things remaining the same, these results can be summarised as follows:

**Result 1**     Any change in the relative price of the import-competing good in the world market is exactly compensated by domestic tariff changes leaving the domestic relative price of the import-competing good unchanged.

**Result 2**     If a sector experiences an exogenous increase in the stock of its specific factor, then the rate of protection awarded to this (growing) sector will decline and the rate of protection awarded to the other sector will rise.

**Result 3**    An exogenous increase in the supply of the mobile factor (labour) in the economy may lead to a fall or a rise in the rate of protection awarded to a sector depending on the relative ease of factor substitution and factor intensity between the two sectors.


## Discussion of the results

Result 1 implies that if, say, the price of the domestic exportable rises in the world market, *ceteris paribus*, then either export subsidies will fall or import taxes will increase to such an extent that the increase in the rationalised tariff rate will exactly offset the effect of the world price change. The domestic economy will be fully insulated against terms of trade shocks. No reallocation of resources will take place.

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**Figure 5    Effects on the bargained tariff rate of an increase in $K_1$**
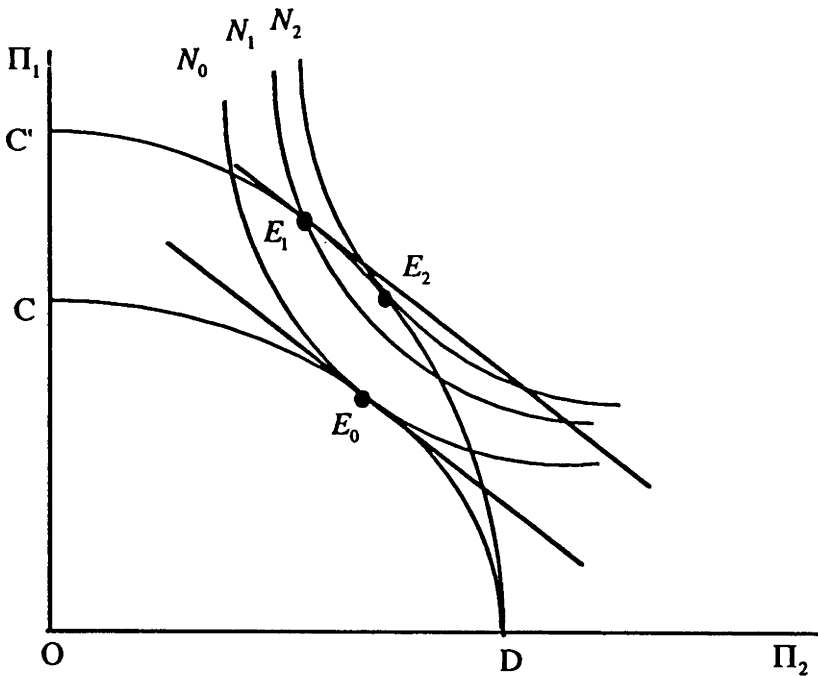


**Source:** Author's own calculations

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The following explanation can be given for the second result that an exogenous increase in the stock of the specific factor in the import-competing sector would lead to a fall in the rationalised tariff rate and/or a rise in the export subsidy. The remaining part of Result 2 (that is, the effect of an increase in the stock of the specific factor in the exporting sector) and Result 3, (that is, the effect of an increased supply of the mobile factor) can be explained in a similar way.

In order to simplify the diagrammatic exposition, it has been assumed in Figure 5 that production functions are Cobb-Douglas in both sectors. Suppose that the point of tangency of Nash product to the rent transformation frontier CD is the initial equilibrium of the tariff game. Suppose further that the capital stock in sector 1 increases exogenously. Then, the RTF will shift upwards to C'D. PXGEM predicts that at an unchanged tariff rate and hence at an unchanged domestic relative price, the output and rental income of sector 1 will increase and the output and rental income of sector 2 will fall. Let $E_1$ describe the combination of the rental incomes (in economic equilibrium) of the two sectors.

From equation (14b) it can be seen that the slope of the RTF depends only on the relative price, since the distributive shares are constant under Cobb-Douglas production functions. Since the point $E_1$ on C'D and the point $E_0$ on CD correspond to the same relative price, the slopes of the frontiers at $E_0$ and at $E_1$ respectively should be equal. However, the absolute slope of the Nash product curve at $E_1$ will exceed the slope of the Nash product curve at $E_0$ (by homotheticity[7], see the curve labelled $N_1$). Therefore, the curve $N_1$ will not be tangent to the frontier C'D at $E_1$. However, their slopes indicate that at $E_1$, player 1's fear of ruin will exceed that of player 2. Therefore, in the new bargaining process, induced by the shock, player 1 will concede and the tariff rate on imports of commodity 1 will fall, leading to a fall in the relative price of commodity 1 in the domestic market. The new bargained equilibrium will be attained at $E_2$ on C'D where both players will be equally fearful of ruin.

The results are very strong, though consistent with general intuition in terms of the direction of the responses. In particular, the result that the domestic economy will be fully insulated against any terms of trade change in the world market can be debated. However, it should be noted that the results are subject to

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[7]When the payoffs at the point of minimum expectation are zero for both players, then the generalised Nash product reduces to a Cobb-Douglas type function. So, the generalised Nash product is clearly homothetic for the same reason as the Cobb-Douglas production function is—that the slope of the level curves at any point depend only on the ratio of the payoffs at that point.

the assumption that the government is expected to be unconstrained with respect to the choice of the tariff rate and as a result the point of minimum expectation is the origin. The reference point is insensitive to changes in the economic environment which are relaxed in the following sections.

## Comparative static behaviour of the endogenous tariff rate: results from illustrative simulations of the general equilibrium model of a political economy with constrained government behaviour

In this section, the comparative static properties of the bargained tariff rate are studied for a more general case. In particular, it is assumed that the prices offered by the government always fall between the autarkic and the free trade equilibrium prices. First, the model is modified to accommodate the consequence of this assumption on the minimum expectations of the players and then a simulation model of the general equilibrium of a political economy is derived. Finally, some numerical simulations are performed to obtain the nature of the comparative static behaviour of the bargained tariff rate. The reason for performing such numerical simulations is that the analytical solutions with constrained government behaviour are found to be inconclusive (see Pant 1992).

## Derivation of a simulation model of the general equilibrium of a political economy

Given that under constrained government behaviour

$$\Pi^d = \Pi^{min} = \left(\Pi_1^*, \Pi_2^a\right)$$

the condition of bargaining equilibrium (15) can be rewritten as

(33)
$$\frac{\Pi_1 - \Pi_1^*}{\Pi_2 - \Pi_2^a} = \frac{\Pi_1}{\Pi_2} \frac{\Theta_1 Y_2 \sigma_2}{\Theta_2 P_1 Y_1 \sigma_1}$$

By holding the distribution of bargaining power and the elasticities of factor substitution constant, equation (33) can be linearised and written in terms of percentage changes of the variables as

(34)
$$D_1\left(\pi_1^0 - \pi_1^*\right) - D_2\left(\pi_2^0 - \pi_2^a\right) = y_2^0 - y_1^0 - p_1^0$$

where,

(35a)
$$D_1 = \frac{\Pi_1^*}{\Pi_1^0 - \Pi_1^*} > 0, \text{ and}$$

(35b)
$$D_2 = \frac{\Pi_2^a}{\Pi_2^0 - \Pi_2^a} > 0$$

By linearising equation (10), percentage changes in rental incomes can be expressed as

(36)     $\pi_i^0 = k_i + r_i^0 - p_i^0$

where it is understood that commodity 2 is the numeraire and, therefore, $p_2^0 = 0$

Now the linearised version of the PEGEM can be written as in Table 2. It is useful to note, however, that equation (34) allows the payoff at the reference point (disagreement payoff) to respond to changes in the exogenous variables. Hence, appended are two other submodels pertaining to the free trade and the autarkic equilibria to obtain expressions for changes in the minimum expectations of the players. The linearised version of the general equilibrium model of the economic sphere at the observed state of equilibrium is called the basic submodel and at the two other states is called free-trade and autarkic submodels. The complete simulation model of the general equilibrium of a political economy (PEGEM) is listed in Table A1. The free trade submodel has been obtained by linearising the model of the economic sphere around the free trade equilibrium and the autarkic submodel have been obtained by linearising the model of the economic sphere around the autarkic equilibrium.

The basic submodel contains, in addition to the equations listed in Table 3, the linearised versions of the equations pertaining to the demand side in which the tariff revenue variable has been expressed in terms of change in its levels and the tariff rate variable has been expressed in terms of changes in percentage points rather than percentage changes as with the other variables.

Note that in Table A1, equations (39) and (40) require that the markets for good 1 and foreign exchange continue to clear after each disturbance to the economy and the labour market will continue to clear by equation (23). It does not say anything about the market of good 2, which will continue to clear by Walras' Law.

## Some strategic considerations

It can be seen from Table A1 that the implementation of the simulation model requires both factual and counterfactual information. Factual information, including the elasticities of factor substitution in the two sectors and various quantity and value shares at the observed state of equilibrium (or 'base year'), is required to calibrate the basic submodel. Counterfactual information that includes the quantity and value shares both at the free trade equilibrium and at the autarkic equilibrium, is required to calibrate the free trade submodel and the autarkic submodel of the simulation model. This section outlines a three-step strategy adopted to generate the counterfactual data sets.

### Calibration of the PEGEM

In the first step, the basic submodel is calibrated using the base year data set assuming that the domestic prices of both goods are unity in the base year.[8]

Step 2 simulates the basic submodel with two different closures. In the first simulation, it is assumed that factor endowment, world prices and the tariff rate are exogenous variables and apply a shock of tariff elimination. The result is then used to update the observed (or base year) data set, which describes the state of the economy at the free trade equilibrium. The updated data set is then used to calibrate the free trade submodel of the PEGEM.

In the second simulation, the closure of the model is changed. The tariff rate is treated as an endogenous variable and the net import of good 1 as the policy variable. Holding other exogenous variables constant, an exogenous policy shock of a 100 per cent cut in the import of good 1 is applied and the model is simulated to obtain its effect on the set of endogenous variables. The result of the simulation yields, among others things, a percentage point increase in the rationalised tariff rate that induces zero trade in both commodities. Updating the base year data set using these results yields the levels of the endogenous variables that describe the economy under autarkic equilibrium. The updated data set is then used to calibrate the autarky submodel of the simulation model listed in Table A1.

In step 3, these two counterfactual descriptions of the economy are used with the observed one to complete the calibration of the simulation model of the general equilibrium of a political economy. It is useful to note, however, that in

---

[8]The general nature of the data set required to obtain sufficient information to calibrate the basic sub-model and generic rules to calculate the relevant shares are outlined in the Appendix A10. It is assumed that the elasticities of factor substitution are known from extraneous sources and remain constant throughout experiments.

the updated (counterfactual) data sets, nominal magnitudes are measured in units of commodity 2, since commodity 2 is the numeraire. To obtain the payoff of player 1 under free trade, which has to be measured in units of commodity 1, the rental incomes in sector 1 must be divided by the relative price of commodity 1 at free trade equilibrium. The relative price of commodity 1 can be obtained from the corresponding updated data set.

To simulate the models, GEMPACK[9] version 4.0.2 was used. This version of the software has the capability to obtain multistep solutions by updating the data base after each step of simulation. The basic principle employed in multi-step simulation can be understood as a polynomial approximation to a curve. Moreover, it also provides a solution using the Richardson extrapolation[10] based on the results of two or three multi-step solutions. The errors due to linear approximations can therefore be reduced considerably by increasing the number of steps in the multi-step simulation.

While simulating the basic submodel, tariff revenue is used as a criterion to judge the accuracy of the results, since tariff revenue has to be zero at both the free trade equilibrium and the autarkic equilibrium. The updated data set is then checked to ensure that markets clear domestically at the autarkic equilibrium and the trade account balances at the free trade equilibrium. This final check ascertains that the update commands have been correctly specified and executed. Though the simulation is intended to be illustrative only, this analysis has used extrapolated results in all cases.

## Preliminary considerations on basic data sets

To extract a general pattern from the simulation results, it is necessary to ask what sort of hypothetical data sets would be required to capture the possible extreme responses of the bargained tariff rate. It can be seen from equation (35), however, that the value of the share-parameters $D_1$, $D_2$ and employment shares depend on the observed position of the economy between autarky and free trade equilibria. The cost share-parameters depend on the elasticities of factor substitution in the two sectors. It follows that the parameters of concern are the observed tariff rate, the elasticities of factor substitution and the relative factor intensities in the two sectors. The first positions the observed equilibrium

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[9]The GEMPACK Software System for solving large economic models was developed by the Impact Project, University of Melbourne, Australia. Details of user guidelines, syntax and semantic can be found in Pearson and Codsi (1991a, 1991b). In the GEMPACK referencing system the documents are normally identified as GED-30, and GED-31 respectively.

[10]For details on Richardson extrapolation see Pearson (1991).

somewhere between free trade and the autarkic equilibrium and the second affects the behaviour of the distributive share parameters and the third links commodity prices and factor returns. Therefore, to achieve some degree of generality, numerical simulations are performed for six hypothetical economies with different parametric configurations. The characteristics of these economies are summarised in Table 3.

The first three economies differ in their tariff regime, the import-competing sector in each of the three types is labour-intensive and the production functions are Cobb-Douglas. The type (d) economy has the same characteristics as that of type (c) except that the factor intensities are reversed. Type (e) and Type (f) economies differ from type (c) economy in elasticities of factor substitution.

Table 3    **Characteristics of six economies at the observed equilibrium**

| Economy Type | Value of $\sigma_1$ | Value of $\sigma_2$ | Tariff regime (rate %) | Relative factor intensity of import -competing sector. |
|---|---|---|---|---|
| (a) | 1.0 | 1.0 | Almost free trade (2) | L-intensive |
| (b) | 1.0 | 1.0 | Almost autarkic (100) | L-intensive |
| (c) | 1.0 | 1.0 | Intermediate (25) | L-intensive |
| (d) | 1.0 | 1.0 | Intermediate (25) | K-intensive |
| (e) | 1.5 | 2.0 | Intermediate (25) | L-intensive |
| (f) | 2.0 | 1.5 | Intermediate (25) | L-intensive |

**Source:** Author's own calculations

## Simulations of the PEGEM

### Calibration, simulation, and discussion of the results

The descriptions of the observed equilibrium of the four economies under three different tariff regimes are provided in Table 4. The description of the last two economies are identical to that of type (c). The figures in Table 4 are values at domestic prices where the units were chosen so as to make the domestic prices of both goods equal to unity. Therefore, the figures can also be regarded as expressions in units of either good, whichever is convenient. From the values of net imports it is apparent that the tariff revenue in cases (a) and (b) is 1 unit of the numeraire, whereas in cases (c) and (d), and hence in cases (e) and (f), it is 5 units.

The rationalised tariff rate is 2 per cent in case (a), 100 per cent in case (b) and 25 per cent in case (c) - (f).[11]

In each of the six cases, the three-step simulation strategy, as described above, was followed to calibrate the PEGEM. The counterfactual data, which describe the equilibrium under autarky and the equilibrium under free trade, were generated in the first two steps of the simulations of the basic submodel and are presented in the top portions of the Appendix Tables A2–A7 respectively. These factual and counterfactual data sets fully describe the bargaining environments. The responses of the endogenous variables with respect to a 1 per cent increase in each of the exogenous variables, namely the relative price of the import-competing good in the world market, stocks of the sector specific factors and the national endowment of labour as predicted by PEGEM and PXGEM are provided in the lower parts.

Table 4    Basic data sets: 'observed equilibrium' in four different economies

|  | wage | rent | value-added | Consumption expend. | net imports |
|---|---|---|---|---|---|
| **Case (a): Almost free trade regime** | | | | | |
| Sector 1 | 70 | 30 | 100 | 151 | 51 |
| Sector 2 | 40 | 60 | 100 | 50 | -50 |
| **Case (b): Almost autarkic regime** | | | | | |
| Sector 1 | 70 | 30 | 100 | 102 | 2 |
| Sector 2 | 40 | 60 | 100 | 99 | -1 |
| **Case (c): Intermediate tariff regime** | | | | | |
| Sector 1 | 70 | 30 | 100 · | 125 | 25 |
| Sector 2 | 40 | 60 | 100 | 80 | -20 |
| **Case (d): Intermediate tariff regime** | | | | | |
| Sector 1 | 30 | 70 | 100 | 125 | 25 |
| Sector 2 | 60 | 40 | 100 | 80 | -20 |

Source: Author's own calculations

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[11]See Appendix Table A9 for methods of calculation.

## Estimates of the bargaining powers of the players

Since the 'observed' data corresponds to the full equilibrium of the economy, and the minimum expectation of player 1 is obtained at the free trade equilibrium and the minimum expectation of player 2 is obtained at the autarkic equilibrium, the data presented in the first part of each Table A2–A7 should satisfy the necessary and sufficient condition of the generalised Nash solution to the bargaining problem in the tariff game. Using these figures, the relative bargaining powers of the two players can be recovered from the condition for bargaining equilibrium. Rewriting condition (15) as

$$(15') \qquad \frac{\Theta_1}{\Theta_2} = \frac{\Pi_2^0}{\Pi_1^0}\left(\frac{\Pi_1^0 - \Pi_1^*}{\Pi_2^0 - \Pi_2^a}\right)\left(\frac{\sigma_2 Y_2^0}{\sigma_1 P_1^0 Y_1^0}\right)$$

The right-hand side of this equation contains known terms and therefore it can be used to solve for the values of the parameters $\Theta_1$ and $\Theta_2$, which measure the bargaining powers of player 1 and player 2 respectively, in the unit interval. As an illustration, the estimates of the bargaining powers of the two players in the first three types of the six economies are provided in Table 5. The estimates show that the exporting sector holds more bargaining power (approximately 24 times) than the import-competing sector in type (a), whereas the import-competing sector holds more bargaining power (approximately 28 times) than the exporting sector in type (b). The players seem to hold almost equal bargaining power in type (c).

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Table 5    The implied bargaining powers of the players in the first three types of economies

| | | Type (a) | Type (b) | Type (c) |
|---|---|---|---|---|
| $\Theta_1/\Theta_2$ : | Bargaining power of player 1 relative to player 2 | 0.04082 | 28.00 | 1.07143 |
| $\Theta_1$ : | Bargaining power of player 1 | 0.04 | 0.97 | 0.52 |
| $\Theta_2$ : | Bargaining power of player 2 | 0.96 | 0.03 | 0.48 |

Source: Author's own calculations

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## Exogenous shocks and endogenous responses of the tariff rate

In the second part of the Tables A2–A5 are presented the comparative static responses predicted by PEGEM and PXGEM of the relevant endogenous

variables as the exogenous variables increase by 1 per cent. Tables A6–A8 contain predictions of the PEGEM only. Note that PEGEM determines the tariff rate endogenously, whereas PXGEM treats tariffs as exogenously determined. The results obtained from simulating PXGEM are based on the assumption that the tariff rate remains constant at the observed level. Hence, the results obtained by simulating the PEGEM also take into account the endogenous responses of the tariff rate. Naturally, the predictions of the PXGEM and PEGEM are different. For example, as world price changed PEGEM has predicted a smaller change (gain or loss) in each of the variables than predicted by PXGEM. This result occurs simply because tariff changes prevent foreign price shocks to be transmitted fully into the domestic economy.

The simulation results presented in Table 6 clearly indicate that the (bargained) tariff rate falls with an increase in the world relative price of the home importable good, the stock of the specific factor in the import-competing sector, or the supply of labour in the economy (if the import-competing good is labour-intensive), and rises with an increase in the stock of the specific factor in the export good-producing sector. The pattern of the responses of the tariff rate has remained intact even when the factor intensities of the sectors were reversed (see Table A5) or when the Cobb-Douglas production functions were replaced by CES production functions (Tables A6–A7).

Table 6    **Change in the tariff rate as the exogenous variables increase by 1 per cent   (percentage points)**

| Type of the economy | Exogenous variables | | | |
|:---:|:---:|:---:|:---:|:---:|
| (a) | -0.06 | -0.02 | 0.03 | -0.01 |
| (b) | -1.89 | -0.57 | 1.16 | -0.58 |
| (c) | -0.57 | -0.17 | 0.35 | -0.17 |
| (d) | -0.61 | -0.42 | 0.24 | 0.18 |
| (e) | -0.66 | -0.14 | 0.29 | -0.15 |
| (f) | -0.65 | -0.12 | 0.33 | -0.20 |

Source: Author's own calculations

## The exogenous shocks and the bargaining equilibrium

The fundamental question is why does the tariff rate change in the first place as the exogenous variables change. In terms of the arguments developed so far, as the exogenous variables change, the perturbation in the equality of the players' generalised fear of ruin holds the key.

More precisely, recall that a generalised Nash solution to a bargaining problem is characterised by the condition that $f_1/\Theta_1 = f_2/\Theta_2$. It can be seen from equations (17a) and (17b) that

$$\frac{f_1}{f_2} = \frac{\Pi_1^0 - \Pi_1^*}{\Pi_2^0 - \Pi_2^a}\left(\frac{-1}{d\Pi_1/d\Pi_2}\right)$$

is the ratio of the two players' fear of ruin.

It follows from equation (17) that a player's fear of ruin increases as its payoff relative to the minimum expectation payoff increases. In other words, a player's fear of ruin (conflict) will increase if either its payoff has increased with unchanged minimum expectation or its payoff at the minimum expectation has fallen at unchanged current payoff level or a combination of both. Intuitively, this means that the more a player has been able to obtain a net gain relative to its minimum expectation the more fearful it will be of conflict with its bargaining opponent. In a Nash bargaining process, the player who fears most relative to its bargaining power will reduce its demand. A Nash equilibrium in the bargaining process is attained when both players' fear of ruin are proportional to their bargaining powers.

If an exogenous shock perturbs the distribution of the payoffs without affecting both the minimum expectation payoffs and the bargaining powers of the players, then the fear of ruin of the player who gains from the shock will increase and the fear of ruin of the player who loses will fall. A similar reasoning holds when both the current payoffs (after the shock at the unchanged policy) and the payoffs at the point of minimum expectation are affected by the shock. The fear of ruin of a player who has gained more relative to its new minimum expectation will also increase by more than that of the other player, who has gained less relative to its new minimum expectation payoff.

Intuitively, the mechanism behind the endogenous response of the tariff rate can be explained as follows. An increase in the world relative price of good 1 not only increases the rental income of player 1 at the unchanged tariff rate but also raises the payoff of player 1 at the free trade equilibrium, which is the minimum expectation of player 1. The minimum expectation of player 2 remains unaffected,

since the autarkic equilibrium is unaffected by changes in the world prices. Since an increase in the payoff at the minimum expectation has the effect of reducing a player's fear of ruin for a given increase in the world price of good 1, the increase in player 1's fear of ruin under constrained government behaviour will be lower than that under unconstrained government behaviour, whereas player 2's fear of ruin declines by the same amount in both cases. This means that player 1 will have to forego less, in terms of a tariff cut, to attain a new bargaining equilibrium under a constrained government than under an unconstrained government, in which case the point of minimum expectation remains at the origin irrespective of the shocks. This, in turn, means that endogenous changes in the tariff rate under a support-maximising government will not be sufficient to offset the world price changes.

Thus, the pattern of the responses of the bargained tariff rate observed in the simulation results is similar to that of the analytical results obtained under unconstrained government behaviour. The difference is that the tariff changes in these cases do not fully insulate the economy from world price changes. This is because the point of minimum expectation responds to the changes in the exogenous variables and does not coincide with the origin. The responsiveness to the shocks of the point of minimum expectation not only changes the bargaining set but also alters the curvature of the level curves of the generalised Nash product by shifting their asymptotes. Nevertheless, the simulation results suggest that in a wide range of situations, the direction of response remains quite robust.

## Some testable hypotheses

On the basis of the above results the following hypotheses or refutable propositions regarding the endogenous behaviour of the tariff rate in the general equilibrium of a political economy, *ceteris paribus*, may be put forward.

(H1)   If the international relative price of the home importable falls (rises) in the world market, then its relative price in the home market also falls (rises), but the bargained tariff rate will rise (fall).

(H2)   If the stock of the specific factor in the import-competing sector increases (decreases) exogenously, then the bargained tariff rate will fall (rise).

(H3)   If the stock of the specific factor in the exporting sector increases (decreases), then the bargained tariff rate will rise (fall).

(H4)   If the supply of labour (or the mobile factor) in the economy increases (decreases) exogenously, then the bargained tariff rate will fall (rise) provided

that the import-competing sector is more labour(capital)-intensive compared to the exporting sector. The tariff rate will remain unaffected by changes in the supply of labour if both sectors are equally labour-intensive.

## Existing literature and credibility of the hypotheses

The first hypothesis is consistent with Hillman's (1982) result that a declining industry will continue to decline even if there are politically motivated tariffs to mitigate the rate of decline of such industries. Long and Vousden (1991) in a more general setting than that considered by Hillman, conclude that Hillman's hypothesis remains robust provided that the owner of the specific factor in the unprotected sector is not significantly less risk averse than the owner of the specific factor in the protected sector.

Magee, Brock and Young (1989), have deduced that any increase in the endowment of a factor in an economy always leads to an increase in the policy favoured by the factor (p. 209). The hypotheses (H2) and (H3), in particular, indicate the contrary. This apparent disagreement between Magee, Brock and Young's result and the predictions of the PEGEM can be reconciled by noting that theirs is a long-run model whereas the PEGEM is essentially a short-run model.

Moreover, observing that tariff rates in the US declined over this century, Magee, Brock, and Young also attempt to correlate this decline with the movements of factor endowments and the US terms of trade changes. They find that changes in the labour–capital ratio had a statistically insignificant effect on tariff rates, whereas terms of trade changes had the expected sign and significant effect on the tariff rate. However, when the first difference of the labour–capital ratio was employed to explain tariff changes it was found to be significant. PEGEM can explain why aggregate endowment changes had insignificant effects on tariff changes. PEGEM predicts that changes in capital stocks in different sectors have opposing effects on the tariff rate and therefore nothing a priori can be said about the effect of a change in the aggregate stock of capital or labour on the tariff rates. If the stock of capital is disaggregated by import-competing and exporting sectors, it is likely that the type of the relationship consistent with the prediction of the PEGEM may be observed.

## An application of the model and some additional hypotheses

Of the four hypotheses, (H2) and (H3) relate the level of domestic protection to the structure of capital formation in the domestic industries. These hypotheses

imply that if an exogenous increase in the stock of the specific factor in the import-competing sector is sufficiently large to more than offset the positive effect on the tariff rate of an increase in the stock of specific factor in the exporting sector, then the country will lower the protection awarded to the import-competing sector. To see whether this result can be obtained, assume that a political economy of type (d), where the import-competing sector is capital-intensive, experiences a very large exogenous growth in the stock of its specific factor, say by 200 per cent. The final state of the political economy after the shock has been simulated using PEGEM and the result are shown in Table 7. The factual and counterfactual data were obtained from Table A5.

Table 7    **Effects of a 200% increase in $K_1$ on the levels of the main variables: Type (d)  (domestic prices)**

|  | Wage | Rent | Value-added | Consump. Expend. | Net Imp. | Price Level |
|---|---|---|---|---|---|---|
| The Economy Before the Shock: | | | | | | |
| Sector 1 | 30 | 70 | 100 | 125 | 25 | 1.0 |
| Sector 2 | 60 | 40 | 100 | 80 | -20 | 1.0 |
| The Economy After the Shock: | | | | | | |
| Sector 1 | 53.08 | 123.84 | 176.92 | 158.55 | -18.37 | 0.72 |
| Sector 2 | 49.39 | 32.93 | 82.31 | 101.47 | 19.16 | 1.00 |

Source: Author's own calculations

Since the size of the shock was very large a convergence problem was encountered. The numbers of steps were increased to 100, 200 and 400. The three multi-step solutions and the extrapolated solution of the model are presented in Table A8, and the updates of the base data (based on the extrapolated solution) are given in Table 7. The extrapolated results show that commodity 1 will be exported in the new equilibrium instead of being imported and the exports of commodity 1 will be taxed at the rate of 10 per cent *ad valorem*. Initially, the imports of commodity 1 were being taxed at the rate of 25 per cent *ad valorem*. On the basis of this exercise the following additional hypotheses are drawn:

A sufficient increase in the stock of a specific factor in the import-competing sector may lead to

(H5)  a reversal in the direction of trade: commodity 1 will be exported and commodity 2 will be imported;

(H6)  a reversal in the direction of tariff protection; and

(H7)  an adoption of a policy of unilateral trade liberalisation.

These hypotheses are consistent with the empirical findings and theoretical results of previous studies. For example, (H5) is consistent with the empirical findings of Martin and Warr (1992), who observe that capital accumulation and technical change, biased against agriculture, have been the most important determinants of the decline in agriculture's share of GDP in Thailand and capital accumulation in case of Indonesia (Warr, 1991). Similarly, (H6) implies that as capital in the import-competing sector builds up, exports of commodity 1 or the imports of commodity 2 will be taxed or the production of commodity 2 will be subsidised. This result is consistent with the fact that developing economies tax agriculture and subsidise manufacturing sectors, while developed economies subsidise agriculture and tax manufactures (Krueger, Schiff and Valdes 1988). Finally, (H7) appears to be consistent with Drysdale and Garnaut's (1992) observation that recent trade liberalisation in the Western Pacific countries has been mostly non-discriminatory and unilateral. However, it also warns that free trade can be sustained only with a particular configuration of factor allocations between the import-competing and exporting sectors.

## Summary

In this paper, a general equilibrium model of a stylised political economy is developed to study the endogenous behaviour of the tariff rate. Simulation of the model using stylised data sets yields some empirically verifiable hypotheses on the endogenous behaviour of the tariff rate.

All of the above hypotheses implied by the PEGEM parallel closely the predictions of a different approach that maximises a conservative social welfare function, in which increases in income are given relatively low weights and decreases very high weights. Underlying this function lies the idea that any significant reduction in real incomes of any significant section of the community should be avoided (Corden 1974:107). A number of reasons such as fairness, social insurance and avoidance of social and political conflict have been forwarded in defence of Corden's Conservative Social Welfare Function.

For example, if the relative price of the import-competing good falls in the world market, then the tariff rate increases by (H1) implying that the policy change compensates, at least partly, for the loss in the real income of player 1. Similarly, the response of the tariff rate implied by (H2)–(H4) can also be predicted by conservative social welfare theorists on grounds of fairness, and so on. The predictions of the PEGEM, however, are not derived by maximising a conservative social welfare function. They are the outcomes of bargaining between the two self-interested players. In this model, the government is also viewed as a self-interested agent which maximises its political support by implementing the agreement reached by the two players.

Hillman (1982) has suggested a point of difference between the two approaches. He argues that the (conservative) social welfare-maximising approach implies that policy change ought to be directed at arresting industry decline, whereas (H1) or politically motivated behaviour of the government implies that a declining industry will continue to decline. However, as has been shown, if a government is unconstrained in choosing a tariff rate, then the policy supplied by the government will meet Hillman's criteria of maximising the conservative social welfare function, which is also the prediction of Stigler-Peltzman model (see Hillman 1982) that policy changes will fully compensate terms of trade changes.

Therefore, it follows that there are problems in differentiating a conservative social welfare-maximising government and a self-interested, politically motivated, support-maximising government. This is particularly true in the case of an unconstrained government. It seems to be an impossible task to characterise a government as guided by public or self-interest simply by observing the policies it chooses. Some further method needs to be devised. However, as argued by Posner (1974) and Vousden (1990), the social welfare-maximising approach lacks explanation on how such functions are formed and translated into legislation, whereas the bargain-theoretic approach, while being able to predict as much, does not suffer from this limitation.

However, if the conservative social welfare function is considered an outcome of a (Nash) bargaining process, then this study can be used to reconcile the difference between the conservative social welfare-maximising approach and the political support-maximising approach to policy determination.

# Appendix

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### Table A1 Simulation model of the general equilibrium in a political economy: PEGEM

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**The Simulation model**
The Political Sphere: Nash bargaining solution

(34) $\quad D_1\left(\pi_1^0 - \pi_1^*\right) - D_2\left(\pi_2^0 - \pi_2^a\right) = y_2^0 - y_1^0 - p_1^0 .$

(36) $\quad \pi_i^0 = k_i + r_i^0 - p_i^0$

Economic Sphere: PXGEM

**The Basic Submodel**

(a) Commodity Markets
*Output supply functions*

(23) $\quad y_j^0 = k_j + \sigma_j\left(\dfrac{S_{Lj}^0}{S_{Kj}^0}\right)\left(p_j^0 - w^0\right) \qquad\qquad j{=}1,2.$

*Consumer demand and tariff revenue*

(37) $\quad c_j^0 = -p_j^0 + \sum_{i=1}^{2} H_i^0\left(p_i^0 + y_i^0\right) + H_3^0 z^0 \qquad j{=}1,2.$

(38) $\quad z^0 = p_1^* + m_1^0 + t/T_1^0$

*Market clearing equations*

(39) $\quad c_1^0 = J_1^0 y_1^0 + J_2^0 m_1^0$

*(Trade balance constraint)*

(40) $\quad m_2^0 = p_1^* + m_1^0$

(b) The Labour Market
*Labour demands functions*

(22) $\quad l_j^0 = k_j + \dfrac{\sigma_j}{S_{Kj}^0}\left(p_j^0 - w^0\right) \qquad\qquad j{=}1,2.$

*The labour market equilibrium condition*

(23) $\quad l = \sum_{j=1}^{2} \lambda_j^0 l_j^0$

(c) The Price Equations
(24) $\quad p_1^0 = p_1^* + \tau^0 t$ and $p_2^0 = 0,$

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Table A1 (contd.)

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### (d) Sectoral Rental Rates

$$(25) \qquad r_j^0 = \frac{1}{S_{Kj}^0}\left(p_j^0 - S_{Lj}^0 w^0\right) \qquad\qquad j=1,2.$$

**The Free Trade Submodel**

(a) Commodity Markets
*Output supply functions*

$$(20f) \qquad y_j^* = k_j + \sigma_j\left(\frac{S_{Lj}^*}{S_{Kj}^*}\right)\left(p_j^* - w^*\right) \qquad j=1,2.$$

*Consumer demand*

$$(37f) \qquad c_j^* = -p_j^* + \sum_{i=1}^{2} H_i^*\left(p_i^* + y_i^*\right) \qquad j=1,2.$$

*Market clearing conditions*

$$(40f) \qquad c_1^* = J_1^* y_1^* + J_2^* m_1^*$$

(Trade balance)

$$(42f) \qquad m_2^* = p_1^* + m_1^*$$

(b) The Labour Market
*Labour demands functions*

$$(21f) \qquad l_j^* = k_j + \frac{\sigma_j}{S_{Kj}^*}\left(p_j^* - w^*\right) \qquad j=1,2.$$

*The labour market equilibrium condition*

$$(22f) \qquad l = \sum_{j=1}^{2} \lambda_j^* l_j^*$$

(c) Price Normalisation Rule
$$(23f) \qquad p_2^* = 0$$

(d) The Rental Rates

$$(24f) \qquad r_j^* = \frac{1}{S_{Kj}^*}\left(p_j^* - S_{Lj}^0 w^*\right) \qquad\qquad j=1,2.$$

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Table A1 (contd.)

**Autarkic Submodel:**

(a) <u>Commodity Markets</u>
*Output supply functions*:

(20a)    $$y_j^a = k_j + \sigma_j \left( \frac{S_{Lj}^a}{S_{Kj}^a} \right)\left( p_j^a - w^a \right)$$

*Commodity demand functions*

(37a)    $$c_j^a = -p_j^a + \sum_{i=1}^{2} H_i^a \left( p_i^a + y_i^a \right)$$

*<u>Market clearing condition</u>*

(40a)    $$c_1 = y_1$$

(b) <u>The Labour Market</u>
*Labour demands functions*

(21a)    $$l_j^a = k_j + \frac{\sigma_j}{S_{Kj}^a}\left( p_j^a - w^a \right)$$    $j=1,2.$

*The labour market equilibrium condition*

(22a)    $$l = \sum_{j=1}^{2} \lambda_j^a l_j^a$$

(c) <u>Price Normalisation Rule</u>
(23a)    $$p_2^a = 0$$

(d) <u>The Rental Rates</u>

(24a)    $$r_j^a = \frac{1}{S_{Kj}^a}\left( p_j^a - S_{Lj}^a w^a \right)$$    $j=1,2.$

**Source:** Author's own calculations

### Table A2    Simulation results for a political economy type (a)

| | Wage | Rent | Value-added | Cons. Expend. | Net Imp. | Price Level |
|---|---|---|---|---|---|---|
| The observed data | | | | | | |
| Sector 1 | 70 | 30 | 100 | 151 | 51 | 1.0 |
| Sector 2 | 40 | 60 | 100 | 50 | -50 | 1.0 |
| Simulated autarky | | | | | | |
| Sector 1 | 143 | 61 | 204 | 204 | 0 | 1.69 |
| Sector 2 | 27 | 40 | 67 | 67 | 0 | 1.0 |
| Simulated free trade | | | | | | |
| Sector 1 | 68 | 29 | 97 | 149 | 52 | 0.98 |
| Sector 2 | 40 | 61 | 101 | 49 | -52 | 1.00 |

**Simulation results**

| Endogenous Variables | Effects of 1% increase in | | | |
|---|---|---|---|---|
| | $P_1^*$ | $K_1$ | $K_2$ | $L$ |
| **PEGEM: Policy-endogenous General Equilibrium Model** | | | | |
| $y_1^0$ | 0.48 | 0.44 | - 0.29 | 0.85 |
| $y_2^0$ | - 0.49 | - 0.14 | 0.89 | 0.25 |
| $r_1^0$ | 1.43 | - 0.57 | - 0.26 | 0.84 |
| $r_2^0$ | - 0.49 | - 0.14 | - 0.10 | 0.25 |
| $w$ | 0.73 | 0.22 | 0.16 | - 0.37 |
| $p_1^0$ | 0.94 | - 0.02 | 0.03 | - 0.01 |
| $t$ (change in percentage pt.) | **- 0.06** | **- 0.02** | **0.03** | **- 0.01** |
| $\pi_1^0$ | 0.48 | 0.44 | - 0.29 | 0.85 |
| $\pi_2^0$ | - 0.49 | - 0.14 | 0.89 | 0.25 |
| $\pi_1^*$ | 0.52 | 0.46 | - 0.32 | 0.86 |
| $\pi_2^a$ | 0.00 | 0.00 | 0.60 | 0.40 |
| **PXGEM: Policy-exogenous General Equilibrium Model** | | | | |
| $y_1^0$ | 0.51 | 0.45 | -0.31 | 0.85 |
| $y_2^0$ | -0.52 | -0.15 | 0.91 | 0.24 |
| $y_2^0$ | 1.52 | -0.54 | -0.31 | 0.85 |
| $r_1^0$ | -0.52 | -0.15 | -0.09 | 0.24 |
| $w$ | 0.78 | 0.23 | 0.13 | -0.36 |
| $p_1^0$ | 1.00 | 0.00 | 0.00 | 0.00 |

Source: Author's own calculations

### Table A3   Simulation results for a political economy of type (b)

| | Wage | Rent | Value-added | Cons. Expend. | Net Imp. | Price Level |
|---|---|---|---|---|---|---|
| The observed data | | | | | | |
| Sector 1 | 70 | 30 | 100 | 102 | 2 | 1.0 |
| Sector 2 | 40 | 60 | 100 | 99 | -1 | 1.0 |
| Simulated autarky | | | | | | |
| Sector 1 | 71 | 31 | 102 | 102 | 0 | 1.01 |
| Sector 2 | 40 | 59 | 99 | 99 | 0 | 1.00 |
| Simulated free trade | | | | | | |
| Sector 1 | 19 | 8 | 27 | 81 | 54 | 0.50 |
| Sector 2 | 53 | 80 | 133 | 79 | -54 | 1.0 |

**Simulation Results**

| Endogenous Variables | Effects of 1% increase in | | | |
|---|---|---|---|---|
| | $P_1^*$ | $K_1$ | $K_2$ | $L$ |

**PEGEM: Policy-endogenous General Equilibrium Model**

| | | | | |
|---|---|---|---|---|
| $y_1^0$ | 0.02 | 0.31 | -0.01 | 0.70 |
| $y_2^0$ | -0.02 | -0.01 | 0.61 | 0.39 |
| $r_1^0$ | 0.07 | -0.97 | 0.57 | 0.41 |
| $r_2^0$ | -0.02 | -0.01 | -0.39 | 0.39 |
| w | 0.04 | 0.01 | 0.58 | -0.59 |
| $p_1^0$ | 0.05 | -0.28 | 0.58 | -0.29 |
| $t$ (change in percentage pt.) | **-1.89** | **-0.57** | **1.16** | **-0.58** |
| $\pi_1^0$ | 0.02 | 0.31 | -0.01 | 0.70 |
| $\pi_2^0$ | -0.02 | -0.01 | 0.61 | 0.39 |
| $\pi_1^*$ | 1.37 | 0.70 | -0.82 | 1.12 |
| $\pi_2^a$ | 0.00 | 0.00 | 0.59 | 0.40 |

**PXGEM: Policy-exogenous General Equilibrium Model**

| | | | | |
|---|---|---|---|---|
| $y_1^0$ | 0.51 | 0.45 | -0.31 | 0.85 |
| $y_2^0$ | -0.52 | -0.15 | 0.91 | 0.24 |
| $r_1^0$ | 1.52 | -0.54 | -0.31 | 0.85 |
| $r_2^0$ | -0.52 | -0.15 | -0.09 | 0.24 |
| w | 0.78 | 0.23 | 0.13 | -0.36 |
| $p_1^0$ | 1.00 | 0.00 | 0.00 | 0.00 |

Source:   Author's own calculations

## Table A4  Simulation results for a political economy of type (c)

|  | Wage | Rent | Value-added | Con. Exp. | Net Imp. | Price Level |
|---|---|---|---|---|---|---|
| The observed data |  |  |  |  |  |  |
| Sector 1 | 70 | 30 | 100 | 125 | 25 | 1.0 |
| Sector 2 | 40 | 60 | 100 | 80 | -20 | 1.0 |
| Simulated autarky |  |  |  |  |  |  |
| Sector 1 | 96 | 41 | 137 | 137 | 0 | 1.24 |
| Sector 2 | 35 | 53 | 88 | 88 | 0 | 1.00 |
| Simulated free trade |  |  |  |  |  |  |
| Sector 1 | 49 | 21 | 70 | 111 | 41 | 0.8 |
| Sector 2 | 45 | 67 | 112 | 71 | -41 | 1.0 |

**Simulation Results**

| Endogenous Variables | Effects of 1% increase in | | | |
|---|---|---|---|---|
|  | $P_1^*$ | $K_1$ | $K_2$ | $L$ |

**PEGEM: Policy-endogenous General Equilibrium Model**

| | | | | |
|---|---|---|---|---|
| $y_1^0$ | 0.28 | 0.38 | -0.17 | 0.78 |
| $y_2^0$ | -0.28 | -0.08 | 0.77 | 0.31 |
| $r_1^0$ | 0.81 | -0.75 | 0.11 | 0.64 |
| $r_2^0$ | -0.28 | -0.08 | -0.23 | 0.31 |
| w | 0.42 | 0.12 | 0.35 | -0.47 |
| $p_1^0$ | 0.54 | -0.14 | 0.28 | -0.14 |
| $t$ (change in percentage pt.) | **-0.57** | **-0.17** | **0.35** | **-0.17** |
| $\pi_1^0$ | 0.28 | 0.38 | -0.17 | 0.78 |
| $\pi_2^0$ | -0.28 | -0.08 | 0.77 | 0.31 |
| $\pi_1^*$ | 0.73 | 0.52 | -0.44 | 0.92 |
| $\pi_2^a$ | 0.00 | 0.00 | 0.60 | 0.40 |

**PXGEM: Policy-exogenous General Equilibrium Model**

| | | | | |
|---|---|---|---|---|
| $y_1^0$ | 0.51 | 0.45 | -0.31 | 0.85 |
| $y_2^0$ | -0.52 | -0.15 | 0.91 | 0.24 |
| $r_1^0$ | 1.52 | -0.54 | -0.31 | 0.85 |
| $r_2^0$ | -0.52 | -0.15 | -0.09 | 0.24 |
| w | 0.78 | 0.23 | 0.13 | -0.36 |
| $p_1^0$ | 1.00 | 0.00 | 0.00 | 0.00 |

**Source:** Author's own calculations

Table A5   Simulation results for a political economy of type (d)

|  | Wage | Rent | Value-added | Con. Exp. | Net Imp. | Price Level |
|---|---|---|---|---|---|---|
| The observed data: |  |  |  |  |  |  |
| Sector 1 | 30 | 70 | 100 | 125 | 25 | 1.0 |
| Sector 2 | 60 | 40 | 100 | 80 | -20 | 1.0 |
| Simulated autarky |  |  |  |  |  |  |
| Sector 1 | 42 | 98 | 140 | 140 | 0 | 1.30 |
| Sector 2 | 54 | 36 | 90 | 90 | 0 | 1.00 |
| Simulated free trade |  |  |  |  |  |  |
| Sector 1 | 22 | 52 | 74 | 110 | 36 | 0.80 |
| Sector 2 | 64 | 43 | 107 | 71 | -36 | 1.00 |

**Simulation results**

| Endogenous Variables | Effects of 1% increase in | | | |
|---|---|---|---|---|
|  | $P_1^*$ | $K_1$ | $K_2$ | $L$ |
| **PEGEM**: Policy-endogenous General Equilibrium Model | | | | |
| $y_1^0$ | 0.17 | 0.82 | -0.07 | 0.25 |
| $y_2^0$ | -0.17 | -0.12 | 0.47 | 0.65 |
| $r_1^0$ | 0.68 | -0.51 | 0.13 | 0.39 |
| $r_2^0$ | -0.17 | -0.12 | -0.53 | 0.65 |
| w | 0.11 | 0.08 | 0.35 | -0.43 |
| $p_1^0$ | 0.51 | -0.33 | 0.19 | 0.14 |
| $t$ (change in percentage pt.) | **-0.61** | **-0.42** | **0.24** | **0.18** |
| $\pi_1^0$ | 0.17 | 0.82 | -0.07 | 0.25 |
| $\pi_2^0$ | -0.17 | -0.12 | 0.47 | 0.65 |
| $\pi_1^*$ | 0.35 | 0.95 | -0.14 | 0.19 |
| $\pi_2^a$ | 0.00 | 0.00 | 0.40 | 0.60 |
| **PXGEM**: Policy-exogenous General Equilibrium Model | | | | |
| $y_1^0$ | 0.33 | 0.93 | -0.13 | 0.20 |
| $y_2^0$ | -0.33 | -0.23 | 0.53 | 0.70 |
| $r_1^0$ | 1.33 | -0.07 | -0.13 | 0.20 |
| $r_2^0$ | -0.33 | -0.23 | -0.46 | 0.70 |
| w | 0.22 | 0.16 | 0.31 | -0.46 |
| $p_1^0$ | 1.00 | 0.00 | 0.00 | 0.00 |

Source:   Author's own calculations

Table A6  Simulation results for a political economy of type (e)

|  | Wage | Rent | Value-added | Con. Exp. | Net Imp. | Price Level |
|---|---|---|---|---|---|---|
| The observed data |  |  |  |  |  |  |
| Sector 1 | 70 | 30 | 100 | 125 | 25 | 1.00 |
| Sector 2 | 40 | 60 | 100 | 80 | -20 | 1.00 |
| Simulated autarky |  |  |  |  |  |  |
| Sector 1 | 94 | 38 | 132 | 132 | 0 | 1.44 |
| Sector 2 | 29 | 55 | 84 | 84 | 0 | 1.00 |
| Simulated free trade |  |  |  |  |  |  |
| Sector 1 | 40 | 20 | 60 | 111 | 51 | 0.80 |
| Sector 2 | 56 | 66 | 122 | 71 | -51 | 1.00 |

**Simulation results**

| Endogenous Variables | Effects of 1% increase in | | | |
|---|---|---|---|---|
|  | $P_1^*$ | $K_1$ | $K_2$ | $L$ |
| **PEGEM** |  |  |  |  |
| $y_1^0$ | 0.45 | 0.38 | -0.07 | 0.68 |
| $y_2^0$ | -0.45 | -0.08 | 0.67 | 0.42 |
| $r_1^0$ | 0.77 | -0.52 | 0.19 | 0.34 |
| $r_2^0$ | -0.23 | -0.04 | -0.17 | 0.21 |
| w | 0.34 | 0.06 | 0.25 | -0.31 |
| $p_1^0$ | 0.47 | -0.11 | 0.23 | -0.12 |
| $t$ (change in percentage pt.) | **-0.66** | **-0.14** | **0.29** | **-0.15** |
| $\pi_1^0$ | 0.30 | 0.59 | -0.04 | 0.45 |
| $\pi_2^0$ | -0.23 | -0.04 | 0.83 | 0.21 |
| $\pi_1^*$ | 1.06 | 0.79 | -0.29 | 0.50 |
| $\pi_2^a$ | 0.00 | 0.02 | 0.77 | 0.21 |

Source:  Author's own calculations

Table A7   Simulation results for a political economy of type (f)

|  | Wage | Rent | Value-added | Con. Exp. | Net Imp. | Price Level |
|---|---|---|---|---|---|---|
| The observed data |  |  |  |  |  |  |
| Sector 1 | 70 | 30 | 100 | 125 | 25 | 1.00 |
| Sector 2 | 40 | 60 | 100 | 80 | -20 | 1.00 |
| Simulated autarky |  |  |  |  |  |  |
| Sector 1 | 96 | 38 | 134 | 134 | 0 | 1.18 |
| Sector 2 | 31 | 54 | 85 | 85 | 0 | 1.00 |
| Simulated free trade |  |  |  |  |  |  |
| Sector 1 | 41 | 21 | 62 | 111 | 49 | 0.80 |
| Sector 2 | 52 | 68 | 120 | 71 | -49 | 1.00 |

**Simulation results**

| Endogenous Variables | Effects of 1% increase in | | | |
|---|---|---|---|---|
|  | $P_1^*$ | $K_1$ | $K_2$ | $L$ |
| **PEGEM** |  |  |  |  |
| $y_1^0$ | 0.39 | 0.34 | -0.11 | 0.77 |
| $y_2^0$ | -0.39 | -0.04 | 0.71 | 0.33 |
| $r_1^0$ | 0.67 | -0.43 | 0.20 | 0.22 |
| $r_2^0$ | -0.26 | -0.03 | -0.19 | 0.22 |
| w | 0.39 | 0.04 | 0.29 | -0.33 |
| $p_1^0$ | 0.47 | -0.10 | 0.26 | -0.16 |
| $t$ (change in percentage pt.) | **-0.65** | **-0.12** | **0.33** | **-0.20** |
| $\pi_1^0$ | 0.19 | 0.67 | -0.06 | 0.39 |
| $\pi_2^0$ | -0.26 | -0.03 | 0.81 | 0.22 |
| $\pi_1^*$ | 0.70 | 0.79 | -0.27 | 0.48 |
| $\pi_2^a$ | 0.00 | 0.03 | 0.71 | 0.26 |

Source:   Author's own calculations

Table A8   **The responses of endogenous variables to an increase of 200% in**
$K_1$ *(Details of the multi-step and extrapolated simulation results)*

| Endogenous Variables | 100-step Results | 200-step Results | 400-step Results | Extrapolated Results |
|---|---|---|---|---|
| $y_1^0$ | 146.470 | 146.360 | 146.314 | 146.274 |
| $y_2^0$ | -17.724 | -17.695 | -17.687 | -17.684 |
| $c_1^0$ | 77.686 | 77.590 | 77.192 | 76.561 |
| $c_2^0$ | 27.496 | 27.481 | 27.241 | 26.845 |
| $m_1^0$ | -198.609 | -198.400 | -197.393 | -195.783 |
| $m_2^0$ | -198.609 | -198.400 | -197.393 | -195.783 |
| $l_1^0$ | 55.5755 | 55.4609 | 55.4240 | 55.4007 |
| $l_2^0$ | -27.775 | -27.724 | -27.709 | -27.700 |
| $p_1^0$ | -28.383 | -28.284 | -28.225 | -28.158 |
| $r_1^0$ | -41.329 | -41.190 | -41.111 | -41.024 |
| $r_2^0$ | -17.725 | -17.695 | -17.688 | -17.684 |
| $w$ | 13.865 | 13.851 | 13.850 | 13.853 |
| $z$ *(change)* | -2.953 | -2.912 | -3.394 | -4.211 |
| $t$ *(change)* | -35.479 | -35.355 | -35.281 | -35.197 |
| $\pi_1^0$ | 146.470 | 146.360 | 146.314 | 146.274 |
| $\pi_2^0$ | -17.725 | -17.695 | -17.688 | -17.684 |
| $\pi_1^*$ | 174.082 | 173.968 | 173.911 | 173.853 |
| $\pi_2^a$ | 2.19E-07 | .000000 | .000000 | 7.30E-08 |

**Source:** Author's own calculations

Table A9:   Generic calculation of share parameters from the base year data set

|  | Wage | Rent | Value Added | Consumption Expenditure | Value of Net Import |
|---|---|---|---|---|---|
| Sector 1 | $WL_1$ | $R_1K_1$ | $P_1Y_1$ | $P_1C_1$ | $P_1M_1$ |
| Sector 2 | $WL_2$ | $R_2K_2$ | $P_2Y_2$ | $P_2C_2$ | $P_2M_2$ |

Source:   Author's own calculations

These data should satisfy the following restriction:

(a)     Zero profit condition - that is for each $i$ we must have $WL_i + R_iK_i = P_iY_i$.

(b)     Market clearing conditions - that is for each $i$ we must have $P_iC_i = P_iY_i + P_iM_i$.

It is clear that conditions (a) and (b) together imply that the aggregate budget constraint of the national consumer holds.

From this data set, we can make the following calculations:

(1)     Tariff revenue equals the sum of the values of net imports at domestic price,

that is,   $Z = P_1M_1 + P_2M_2$

follows from the condition that trade balances at world prices.

(2)     The rationalised tariff rate $T_1 = -Z/P_2M_2$

(3)     Employment shares:     $\lambda_i = \dfrac{WL_1}{WL_1 + WL_2}$

by the assumption of perfect mobility and homogeneity of labour.

(4)     Distributive shares:     $S_{Li} = WL_i/P_iY_i$ and $S_{Ki} = R_iK_i/P_iY_i$.

(5)     Tariff coefficient $\tau = 1/(1 + T_1)$.

The share parameters H's and J's are calculated as follows.

(6)     $H_i = \dfrac{P_iY_i}{\displaystyle\sum_{i=1}^{2} P_iY_i + Z}$,          $i=1,2$; and $H_3 = \dfrac{100}{\displaystyle\sum_{i=1}^{2} P_iY_i + Z}$.

(7)     $J_1 = \dfrac{P_1Y_1}{P_1C_1}$ and $J_2 = \dfrac{P_1M_1}{P_1C_1}$.

# References

Aumann, Robert J. and M. Kurz, 1977. 'Power and taxes.' *Econometrica*, 45:1137-61.

Baldwin, Richard 1987. 'Politically realistic objective functions and trade policy.' *Economics Letters*, 24:282-90.

Binmore, K. 1987. 'Perfect equilibria in bargaining models', in K. Binmore and P. Desgupta (eds.), *The Economics of Bargaining*. Basil Blackwell:77-105.

_____, Ariel Rubinstein and Asher Wolinsky 1986. 'The Nash bargaining solution in economic modelling.' *Rand Journal of Economics*, 17:176-88.

Carlson, Hans 1991. 'A bargaining model where parties make errors.' *Econometrica*, 59:1487-96.

Chun, Youngsub 1988. 'Nash solutions and timing of bargaining.' *Economics Letters*, 28:27-31.

_____, Theodore Graham-Tomasi and Terry Roe 1991. 'Existence of equilibrium in a lobbying economy.' *International Economic Review*, 32:533-50.

Corden, W.M. 1974. *Trade Policy and Economic Welfare*. Oxford University Press, Oxford.

Drysdale, Peter and Ross Garnaut 1992. *The Pacific: An Application of a General Theory of Economic Integration*. A Paper Presented in the Twentieth Pacific Trade and Development Conference, Institute of International Economics, Washington DC.

Friedman, James W. 1986. *Game Theory with Applications to Economics*. Oxford University Press, Oxford.

Fudenberg, Drew and Eric Maskin 1986. 'The folk theorem in a repeated games with discounting and incomplete information.' *Econometrica*, 54:533-55.

Gardner, B.L. 1983. 'Efficient redistributions through commodity markets.' *American Journal of Agricultural Economics*, 65:225-34.

Hall, H. Keith and Douglas Nelson 1992. 'Institutional structure in the political economy of protection: legislated v. administered protection.' *Economics and Politics*, 4:61-77.

Harsanyi, John C. 1963. 'A simplified bargaining model for the n-person cooperative game.' *International Economic Review*, 4:195-220.

_____, and R. Selton 1972. 'A generalised Nash solution for two-person bargaining games with incomplete information.' *Management Science*, 18:80-106.

Hillman, A.L. 1982. 'Declining industries and political-support protectionist motives.' *American Economic Review*, 72:1180-7.

Kalai, E. 1977. 'Nonsymmetric Nash solutions and replications of 2-person bargaining.' *International Journal of Game Theory*, 6:129-33.

Krueger, A.O., M. Schiff and A. Valdes 1988. 'Agricultural incentives in developing countries: measuring the effects of sectoral and economywide policies.' *World Bank Economic Review*, 2:255-72.

Long, Ngo Van and Neil Vousden 1991. 'Protectionist responses and declining industries.' *Journal of International Economics*, 30:87-103.

Magee, Stephen P., William A. Brock and Leslie Young 1989. *Black Hole Tariffs and Endogenous Policy Theory.* Cambridge University Press, Cambridge.

Martin, W. and Peter G. Warr 1992. *The Declining Economic Importance of Agriculture: A Supply Side Analysis for Thailand.* Working Papers in Trade and Development 92/1, Department of Economics, The Australian National University, Canberra.

Nash, John 1953. 'Two-person cooperative games.' *Econometrica*, 21: 128-40.

Neary, J.P. 1978. 'Short-run capital specificity and the pure theory of international trade.' *Economic Journal*, 88:488-510.

Ng, Yew-Kwang 1981. 'Bentham or Nash? On the acceptable form of social welfare function.' *Economic Record*, 57:238-50.

Ohyama, Michiro 1989. 'Bargaining with differential skills.' *KEIO Economic Studies*, 26:1-4.

Pearson, K.P. 1991. *Solving Nonlinear Models Accurately via a Linear Representation.* Impact Working Paper IP-55, Impact Project, Melbourne.

Posner, Richard A. 1974. 'Theories of economic regulation.' *Bell Journal of Economics and Management Science*, 5:335-8.

Roth, Alvin E. 1977. 'Independence of irrelevant alternatives, and solutions to Nash's bargaining problem.' *Journal of Economic Theory*, 16:247-51.

_____, 1979. *Axiomatic Models of Bargaining.* Springer-Verlag, Berlin.

Rubinstein, A. 1982. 'Perfect equilibrium in a bargaining model.' *Econometrica*, 50:97-110.

Subik, Martin 1982. *Game Theory in Social Sciences, Concepts and Solutions.* The MIT Press, Cambridge.

Svejnar, Jan 1986. 'Bargaining power, fear of disagreement, and wage settlements: theory and evidence from U.S. industry.' *Econometrica*, 54:1055-78.

Thomson, William 1981. 'A class of solutions to bargaining problems.' *Journal of Economic Theory*, 25:431-41.

Vousden, Neil 1990. *The Economics of Trade Protection.* Cambridge University Press, Cambridge.

Warr, P.G. 1991. *Agriculture's Relative Decline and the Problem of Labour Absorption: Evidence from Indonesia.* Working Papers in Trade and

Development 91/5, Department of Economics, The Australian National University, Canberra.

Zuthen, Frederik 1930. *Problem of Monopoly and Economic Welfare*. G. Routledge, London.

Pant, H.M. 1992. Tariff determination in general equilibrium: a bargain-theoretic approach to policy modelling, PhD Thesis, The Australian National University, Canberra.

Pearson, K and G. Codsi 1991a. The update and multi-step version of tablo: user guidelines. First edition. GED-30 (mimeo). The Impact Project (August), Melbourne.

_____, 1991b. The update and multi-step version of tablo: syntax and semantic description. First edition. GED-31 (mimeo). The Impact Project (August), Melbourne.

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