Imperfect Competition and the Theory of Managed Trade*

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Abstract

Abstract: We analyze the role of imperfect competition in explaining the relationship between temporary surges in trade-volumes and the level of cooperation in trade policy that can be sustained between countries in a repeated game framework. Imperfectly competitive markets are characterized by a mark-up which is the wedge between equilibrium price and the marginal cost of production. Absent domestic policy tools, gains from protectionist policies are shown to depend positively on the size of the mark-up in the domestic import-competing sector, which is in addition to the conventional terms-of-trade related benefits. A temporary surge in trade-volume due to a supply-side shock lowers the industry mark-up making protectionist policies less desirable. This counters the increase in the terms-of-trade related benefits due to higher trade-volume. The net effect of these two competing forces determines whether periods of abnormally high trade-volumes feature more or less cooperation along the equilibrium path of the repeated game. We identify simple conditions distinguishing between these two outcomes thereby establishing the pattern of "managed trade" under imperfect competition. A sharp distinction is drawn between demand side and supply side shocks. We suggest a simple generalization of the results to other forms of distortions.

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Introduction

Two central issues in the literature on trade policy are the potential gains from international trade agreements and how such agreements can be enforced. A simple explanation of the benefits from trade agreements is that the pursuit of unilateral interest in the setting of trade policy by a country leads to welfare losses through reduced market access for the partner country. Since the country in question which imposes trade restrictions does not bear this cost, it is tempted to supply protection beyond the globally efficient level. A "Prisoner's Dilemma" type situation emerges when all countries pursue this beggar-thy-neighbor policy. Trade agreements are beneficial in that they can help unlock these externalities by moving the countries from the inefficient high levels of protection to globally efficient ones (Bagwell and Staiger, 1999, 2002). A second rationale for trade agreements is that, when a government lacks credibility vis-a-vis its domestic private agents, then the time-consistent policy is sub-optimal. An *ex ante* commitment through a trade agreement can be welfare improving by enhancing the government's credibility (Maggi and Rodriguez-Clare, 1998). However, whether the economic benefits of international trade agreements stem from their potential to limit the temptation to pursue beggar-thy-neighbor trade policies or their potential to enhance the government's credibility, the temptation for unilateral trade policy choices does not go away once an agreement is in place (Staiger, 1995, p. 1519). Thus, it is imperative to consider precisely what kind of agreements can be enforced in relation to the underlying economic environment. The present paper attempts to shed light on this by focusing on the enforcement issue when markets are imperfectly competitive and countries are tempted to follow beggar-thy-neighbor policies in the sense mentioned above.

A prior question that we need to consider is the mechanism through which trade agreements are to be enforced. Since countries trade repeatedly over time, a natural possibility is to use the threat of future punishment to deter violations of trade agreements. A credible threat of future punishment can sustain a more liberal trading environment than that predicted under the static Nash equilibrium (Bagwell and Staiger, 1990; Dixit 1987b; Jensen and Thursby, 1984). While most of the work in this area helps explain how the temptation for unilateral policies can be curtailed, a notable feature of Bagwell and Staiger is that it explains how the achieved level of cooperation varies in a *changing* environment. Specifically, in a perfectly competitive partial equilibrium framework, they show that the potentially exploitable terms-of-trade related gains are higher during periods of high trade-volumes so that in such periods the country has greater incentive to deviate from an initial tariff agreement. An immediate outcome of this is that if the surge in trade-volume is sufficiently high then cooperative tariffs need to be raised to keep the unilateral incentive to deviate in check. Thus, the model predicts low baseline tariffs during normal periods with "special" (high) protection during periods of high trade-volumes. Bagwell and Staiger refer to this dynamic structure of achieved level of cooperation as "managed trade".

The present paper builds on this work by analyzing the impact of imperfect competition on the dynamic structure of sustainable cooperation; that is, the pattern of managed trade under imperfect competition. We consider a simple partial equilibrium model with two symmetric countries. Each country produces an import-competing and an exportable good under imperfect competition in addition to a common numeraire good which is produced under perfect competition. Markets for the non-numeraire goods are segmented by construction of the model. To motivate the basic arguments, consider the case when an import tariff is the only policy instrument available. A strictly positive tariff imposed by, for example, the home country, leads to the conventional terms-of-trade related gains for it and at the same time increases its production of the importable. This larger production of the importable increases home's welfare through a first order effect since production in the sector is distorted to begin with. Specifically, a unit increase in the output of the import-competing sector increases home's welfare, when evaluated at the margin and at the original world and local prices, by an amount equal to the difference between the equilibrium local price and the marginal cost of production which is the industry "mark-up".[1] This source of benefit from protection is completely absent when markets are perfectly competitive since allocation of resources is then optimal.[2] This point is well-known in the literature.[3] Thus, it is simple to see from this that the benefit from protectionism and thus, the pattern of managed trade will be governed by the dynamics of the mark-ups and the terms-of-trade related gains. Now consider an abnormal period in the sense of Bagwell and Staiger featuring a temporary surge in import-volume due to a supply side shock which can be either a higher marginal cost of production of the importable in home or a lower cost of production of home's importable in the foreign country. With tariffs held fixed momentarily, such shocks lead to lower equilibrium mark-up in home's import-competing sector implying a lower incentive to deviate (the *mark-up effect*). Of course, the terms-of-trade related gains will be larger due to

[1] Or, more precisely, the "price-marginal cost mark-up".

[2] We are assuming here that the first-best policy tool, domestic production subsidy to the imperfectly competitive sectors, is unavailable to the governments so that the use of tariffs, and trade restrictions in general, to correct for this distortion is, as described in the literature, a "second-best" argument.

[3] See, for example, Flam and Helpman (1987). We discuss this point in more detail in the sections that follow.

larger import-volume which will increase the incentive to deviate (the *terms-of-trade effect*). Overall, the incentive to deviate will fall if and only if the *mark-up effect* is stronger than the *terms-of-trade effect*. When this happens then we get a simple theory of managed trade with greater cooperation (lower tariffs) precisely in periods of high trade-volumes. This is in sharp contrast to the results in Bagwell and Staiger. It is simple to see from this that when the surge in import-volume is due to demand side shocks then the two effects mentioned above will be reinforcing producing a pattern of managed trade similar to the one in Bagwell and Staiger. Thus, our results draw a sharp distinction between demand and supply side shocks which has been completely neglected in the theoretical and empirical work.

The present paper builds on the theme mentioned above and seeks to identify conditions that determine the qualitative aspects of the pattern of managed trade. Importantly, we suggest a simple generalization of our results to other forms of imperfections common in the literature.

The outline of the remaining paper is as follows. In section 1 we set up the basic model and derive the static equilibrium and interpret its properties. In section 2 we introduce the dynamic elements of the repeated game and derive the pattern of managed trade when tariffs are the only policy tool available and there are cost-based shocks in the exportable sector of each country. In section 3 we extend the basic findings of section 2 to supply side shocks in the import-competing sectors, demand side shocks and, to the case when export policies are also used. In the conclusion we summarize our findings and suggest a simple generalization to other forms of imperfections.

Section 1

1.1 *Basic structure of the static game*

We consider a model with two countries called home and foreign. There are three goods labelled Z, X and Y. To keep the model simple, we assume that home-agents consume goods Z and X while foreign-agents consume goods Z and Y. Utility function of a representative home-agent is given by: $C_z + \alpha C_x - \beta C_x^2/2$ where $C_x(C_z)$ denotes his consumption level of good $X(Z)$; α, β are assumed to be strictly positive parameters and given exogenously. Similarly, utility of a representative agent in the foreign country is given by: $C_z^* + \alpha C_y^* - \beta C_y^{*2}/2$ where $C_y^*(C_z^*)$ is the amount of good $Y(Z)$ consumed by the agent.[4] Without loss of generality to our results, we normalize the total number (measure) of agents in each country to unity.

We next introduce the price notations. Let P_z, P_x denote the absolute prices of goods Z, X, respectively, in home's local market. Similarly, let P_z^*, P_y^* denote the local prices of goods Z, Y, respectively, in foreign's local market. For the rest of the model we will treat good Z as the common numeraire good for both the countries. Thus, the relative price of good $X(Y)$ in home's (foreign's) local market is equal to $p_x \equiv P_x/P_z$ ($p_y^* \equiv P_y^*/P_z^*$).

We assume that, at the beginning of each period, each country receives a fixed endowment of the numeraire good and none of the other goods. This endowment is either consumed within the period or used to produce the non-numeraire goods. Assume that the endowment is sufficiently large so that good Z is always consumed in a strictly positive amount. We will denote the cost of producing one unit of good $X(Y)$ in the home country by $c_m(c_n)$ and that

[4] The symmetry of the utility function between the numeraire and the non-numeraire goods across the two countries has no bearing on our results.

in the foreign country by $c_n(c_m)$, as measured in terms of the numeraire good. Thus, cost-structure in the two countries is symmetric in that home's import-competing sector (sector X) is symmetric to foreign's (sector Y).[5] For tractability, subscript $m(n)$ will always refer to the import-competing (export) sectors of the two countries.

We next introduce the market structure. As in Brander and Krugman (1983), we assume that, in each country, market for good Z is perfectly competitive while there is imperfect competition in the non-numeraire good's markets. Intuitively, we consider the situation where there are a fixed number of firms that possess the necessary technical know-how to produce the non-numeraire goods. In the home country, there are $m(n)$ number of firms that can produce good $X(Y)$. To ensure symmetry of the type discussed above, we assume that in the foreign country there are $n(m)$ number of firms that produce good $X(Y)$. We will treat m, n as strictly positive integer values, given exogenously to the model. To keep the model simple, we assume that the ownership of firms in the non-numeraire sectors is extremely concentrated so that firms in these sectors maximize their profits in the conventional sense.[6]

The solution concept used in the paper is the standard Cournot oligopoly solution with quantity competition. The oligopolistic structure outlined above is similar to the one in Dixit (1984) and Brander and Krugman.[7]

We now introduce trade policies. Throughout the paper we will assume that there is free

[5] The cost structure can be alternatively derived from Ricardian technology with labor as the only factor of production and constant input-ouput coefficients equal to $1, c_m, c_n$ in the home country for goods Z, X, Y respectively. The corresponding coefficients for the foreign are $1, c_n, c_m$.

[6] The assumption implies that the output decision of firms is independent of tariff revenue considerations and of the market prices that the owners of firms themselves face as consumers. For more details on this see, for example, Grossman and Helpman (1994, pp. 846-847).

[7] The oligopolistic structure of markets here over-simplifies the complexity of imperfectly competitive markets in the real world. However, we believe that it is a convenient way to highlight our main result regarding the *mark-up effect* discussed later in the paper which is likely to be preserved under richer environments.

trade in the numeraire good which serves to balance trade between the two countries.[8] For trade in the non-numeraire goods, we allow for import tariffs and export subsidies. For home we will denote these by t, e, respectively, with t being a non-negative specific tariff and e the per-unit subsidy which can be either positive or negative.[9] For the foreign country, these policy levels will be denoted by t^*, e^*, respectively. Throughout the paper we will maintain that the government in each country maximizes its (pure) national welfare. Tariff revenue, if any, is distributed back uniformly to the country's consumers in a lump-sum fashion. The same holds for the export-subsidy.[10] Since the numeraire good does not play any active role in our analysis, in the remainder of the paper "goods" and "sectors" will imply non-numeraire goods and sectors.

This completes the basic structure of the static model. As will be clear from the solution derived below, the markets for goods X, Y are segmented. This, coupled with the symmetric nature of the model, simplifies our algebra considerably and allows us to draw sharp results.

1.2 *Solution of the static game*

From the utility functions stated above we get that home's (aggregate) inverse demand function for good X is given by $p_x = \alpha - \beta X^d$, where X^d is the amount of good X demanded by all of home's consumers.

We will assume that the solution values are strictly interior in that all equilibrium prices, output level of each good in each country and trade-volumes are strictly positive. Interior

[8] Free trade in the numeraire good sector is frequently assumed in the literature. See, for example, Bagwell and Staiger (1997, page 96, footnote 5); Brander and Krugman (1983).

[9] Our motivation for ruling out negative tariffs is that they are rarely observed in the real world. However, our results are qualitatively preserved even if these are allowed.

[10] That is, when the export subsidy is negative then this is distributed back to the country's agents in a lump-sum fashion. When the subsidy is positive then the cost of this is met through a lump-sum transfer from the private agents to its government.

solution conditions are specified later which ensure this result.[11]

To derive equilibrium prices and production levels we need to specify the best response functions of the firms. To this end, treat all policy variables as exogenously fixed at arbitrary levels. Profit of the i^{th} home-firm in sector X is equal to $[\alpha - \beta(x_i + X_{-i}) - c_m]x_i$ where x_i is the output of the firm and X_{-i} is the aggregate output of all the remaining (home and foreign) firms in the sector. The best response output of the firm is equal to $x_i(X_{-i}) \equiv (\alpha - \beta X_{-i} - c_m)/2\beta$. Similarly, profit of the j^{th} foreign-firm in sector X producing output level x_j^* is equal to $[\alpha - \beta(x_j^* + X_{-j}) - c_n + e^* - t]x_j^*$ where X_{-j} is the aggregate output of all the other firms in the sector. The best response output of the firm is equal to $x_j^*(X_{-j}) \equiv (\alpha - \beta X_{-j} - c_n + e^* - t)/2\beta$. We now impose an additional symmetry assumption that all home-firms produce an equal level of output in equilibrium. A similar assumption holds for all the foreign-firms in the sector. The assumption is natural since all home-firms in the sector are identical. The same holds for the foreign-firms. With this in place we get that the aggregate equilibrium output of foreign-firms in sector X which is home's total import-volume is equal to[12]

$$V = V(V^f, t, e^*) \equiv V^f - \frac{n(1+m)(t-e^*)}{\beta(1+m+n)}$$

$$V^f \equiv \frac{n[\alpha + mc_m - (1+m)c_n]}{\beta(1+m+n)}$$

where V^f is home's import-volume under complete free trade in good X; that is, when t, e^* are each equal to zero.

[11] These are stated in Assumption A1 in section 2.

[12] It can be easily checked that the sufficiency conditions of Hahn (1962) for the stability of the Cournot-Nash equilibrium are satisfied due to the linearity of the aggregate demand function.

The total output of home-firms producing good X is equal to

$$X_m = X_m^f + \frac{mn(t-e^*)}{\beta(1+m+n)}$$

where X_m^f is home's production of the importable with t, e^* equal to zero.[13]

Total world output and home's consumption of good X will be denoted by $X \equiv V + X_m$. Equilibrium (relative) price of good X in home's local market will be denote by p_x and its value is equal to $\alpha - \beta X$ where X is as in the previous identity.[14] Using the linkage condition, we get the (untaxed) world price of good X, defined from home's point of view, as equal to $p_x - t \equiv p_x^w$. Computing we get

$$p_x^w = \frac{\alpha + mc_m - \beta V^f}{1+m} - \frac{ne^* + (1+m)t}{1+m+n}$$

Solution values of the variables for the foreign country can be obtained symmetrically. That is, let V^*, Y^*, p_y^* denote the equilibrium values of foreign's total import volume, total consumption of good Y, local price of Y (in foreign's market), respectively. Values of these variables are exactly the same as for V, X, p_x, respectively, with t replaced by t^* and, e^* by e. The same substitution of policy variables in the expression for X_m gives the aggregate equilibrium output of foreign-firms producing good Y and this will be denoted by Y_m^*. To complete the solution, we define p_y^{*w} as the world price of good Y from foreign's point of view. That is, $p_y^{*w} = p_y^* - t^*$. It's value is given by the same equation as for p_x^w above with e^*, t replaced by e, t^*, respectively.

An important feature of imperfectly competitive markets is that sectoral allocation of

[13] Expression for X_m^f is stated in Appendix A1.

[14] Expression for p_x is stated in Appendix A1.

resources may not be efficient. To capture this, we first introduce the industry mark-ups relevant to our model.

The mark-up in home's import-competing sector is simply the difference between the equilibrium price of good X in home's local market and home's marginal cost of producing the good. Formally, we will denote this by $\mu_x \equiv p_x - c_m$. Computing we get

$$\mu_x = \mu_x(\mu^f, t, e^*) \equiv \mu^f + \frac{n(t - e^*)}{1 + m + n}$$

$$\mu^f = \mu^f(V^f, c_m, \alpha) \equiv \frac{\alpha - c_m - \beta V^f}{1 + m}$$

where μ^f is the value of home's mark-up in the sector with t, e^* equal to zero.

For the foreign country, we will denote its mark-up in its import-competing sector (sector Y) by $\mu_y^* \equiv p_y^* - c_m$. We note here that the solution for this is symmetric to home's; that is, $\mu_y^* = \mu_x(\mu^f, t^*, e)$. For tractability, we will use V^{*f}, μ^{*f} to denote foreign's import-volume and mark-up, respectively, when t^*, e are each equal to zero.[15]

From the solution cited above we note our first Lemma which will be useful in later sections.

Lemma 1

With all policy variables held fixed in home and foreign, we have that:

(i) An outward shift in home's demand for its importable good increases its equilibrium import-volume *and* the mark-up. That is, $\partial V/\partial\alpha > 0$ and $\partial\mu_x/\partial\alpha > 0$. Similarly, for the foreign country, $\partial V^*/\partial\alpha > 0$ and $\partial\mu_y^*/\partial\alpha > 0$.

[15] It is straightforward to note that $V^{*f} = V^f$, $\mu^{*f} = \mu^f$.

(ii) A supply side shock in sector X in either the home country or the foreign country changes home's import-volume and mark-up in *opposite* directions. That is, $\partial V/\partial c_m > 0$ while $\partial \mu_x/\partial c_m < 0$. Similarly, $\partial V/\partial c_n < 0$ while $\partial \mu_x/\partial c_n > 0$.[16] By symmetry, the same results hold for V^* and μ_y^*.

Lemma 1 is useful in that it provides an intermediate step in establishing the relationship between periodic shocks in demand and supply conditions (values of α, c_m, c_n) and each country's benefit from cooperation relative to deviation. This will be critical in the sections that follow where we consider how a country's incentive to deviate from a proposed tariff agreement varies with fluctuations in its underlying trade-volume and mark-up.

1.3 *Welfare functions*

From the solution above we can easily compute home's national welfare which will be denoted by W. We have that

$$W = W(V^f, \mu^f, c_m, c_n, \alpha, t, e, t^*, e^*)$$
$$\equiv (\beta/2)X^2 + tV + \mu_x X_m + (p_y^* - c_n - t^*)V^*$$

The first term on the right-hand side (RHS) of the identity is home's (consumer) surplus from the consumption of good X, the second term is its total tariff revenue, the third term is home's producer surplus in sector X and, the last term is its producer surplus from production and export of good Y net of export subsidy. Foreign's welfare is symmetric to home's and will be denoted by $W^* \equiv W(V^f, \mu^f, c_m, c_n, \alpha, t^*, e^*, t, e)$.

This completes the basic solution of the static game. Since the solution is symmetric across countries, the rest of the results will be developed from home's point of view and will

[16] The partial derivatives throughout the Lemma indicate that all policy variables are treated as fixed.

apply to foreign in a symmetric way.

Section 2: Import tariffs

In this section we consider the case when import tariff is the only policy tool available. Our motivation for focusing on this case first is that it broadly reflects the real-world situation and also that it allows us to compare our results with the ones in the literature where import tariff is often assumed to be the only policy instrument. Thus, for the remainder of this section we set e, e^* equal to zero.

2.1 *Static Nash equilibrium tariffs*

Home's marginal benefit from its tariff can be expressed as

$$\partial W/\partial t = W'(V^f, \mu^f, t) = -V\partial p_x^w/\partial t + t\partial V/\partial t + \mu_x \partial X_m/\partial t \quad .....(1)$$

In the previous equation, the first two terms together capture home's conventional terms-of-trade related benefit net of consumption and production distortion of the tariff. The third term relates to imperfect competition. In particular, a unit increase in home's tariff increases it's production of the importable by an amount equal to $\partial X_m/\partial t > 0$ and lowers that of the numeraire good. Under perfect competition, such re-allocation of production has a *second order effect* only on its welfare since the allocation of resources is optimal to begin with (price equals marginal cost so that $\mu_x = 0$). However, with imperfect competition in the sector, equilibrium price is strictly higher than the marginal cost ($\mu_x > 0$) so that a unit increase in the production of the good increases home's welfare by a *first order effect* which, at the margin, is equal to μ_x. Thus, we interpret home's mark-up simply as the size of the distortion in the allocation of resources due to imperfect competition.[17] This point is well-known in the literature and is also referred to as the "own output pro-competitive effect." For example, Flam and Helpman (1987, p. 90) note that:

> "The point is that whenever price exceeds marginal production costs, there is a welfare gain to be made from output expansion. The larger the difference between price and marginal costs, the larger the gain per unit of additional output."[18]

We would like to point out here that this source of welfare improvement does *not* reflect the "strategic benefit" from protection. A simple way to see this is to note that the term $\mu_x \partial X_m / \partial t$ is evaluated at the original prices and arises because of the change in home-firms' *own* output. The strategic benefit as, for example, in Brander-Spencer models, arises purely from the price movement resulting from the change in the output of the rival (foreign) firms. Further, it is also different from the benefit from protection suggested in the literature on trade policy under monopolistic competition and increasing return to scale. Studies in this area reveal additional sources of gains from protection such as the exercise of monopoly power in the foreign market even for a small economy due to differentiated products (Gros 1987), achieving the optimal number of varieties produced domestically and imported (Venables,1982; Flam and Helpman) and realizing greater economies of scale.[19]

[17] By symmetry, a similar interpretation holds for foreign's mark-up, μ_y^*.

[18] There is a wide body of empirical evidence on the significance of price-marginal cost mark-ups and their relationship to import penetration ratios, import-tariffs and other trade barriers. For example, Levinsohn (1993) finds that the large scale removal of import protection in the Turkish manufacturing sector in 1984 led to a significant decline in the price-cost mark-ups in these sectors. For a literature survey on this area see, for example, Feenstra (1995).

[19] Gros explicitly notes that his optimal tariff "does not correct a domestic distortion". Also, with increasing returns to scale, a positive tariff may be beneficial to a small country as it expands domestic production of the importable thus lowering the average fixed cost. This effect is completely absent in our model.

From equation (1) it is evident that home's tariff has no effect on the producer surplus in its export sector and also that $W'(.)$ is independent of foreign's tariff. Both these results follow from the fact that markets for X, Y are completely segmented.

It will be useful to rewrite equation (1) in terms of V^f, μ^f. Doing this we have that

$$W'(V^f, \mu^f, t) = \frac{(1+m)V^f}{1+m+n} + \frac{mn\mu^f}{\beta(1+m+n)} - \frac{n[n+2(1+m)^2]}{\beta(1+m+n)^2}t \quad .....(2)$$

We set $W'(.) = 0$ and solve for home's interior best response tariff. Let this be denoted by t_n.[20] From the previous equation it can be seen that t_n is well defined, unique, strictly positive and independent of the tariff set by the foreign country. From equation (2) it is evident that t_n is strictly increasing in V^f, μ^f and it is also home's optimal and the static Nash equilibrium tariff. The exact value of t_n is stated in Appendix A1. It can be easily checked that $W(.)$ is globally strictly concave in t so that the second order maximization condition is satisfied.

We now impose our interior solution condition which is as follows.

Assumption A1: $\alpha > max\{c_m, c_n\}$ and $c_m > c_n$.

The first inequality in Assumption A1 is standard in the literature and it ensures that the equilibrium output level (absent any policy intervention) of all firms and equilibrium prices are strictly positive. The second part of the assumption, $c_m > c_n$, is a simplifying assumption which implies that: (i) t_n is non-prohibitive[21] and, (ii) free trade maximizes the static joint welfare ($W + W^*$ value) of the two countries. In section 3.3 we put forward a weaker set of assumptions allowing c_m to be less than c_n and argue that our main results are

[20] By symmetry, the best response tariff of the foreign country is also equal to t_n.

[21] Prohibitive tariff of each country when tariffs alone are used is equal to $t_R \equiv \beta(1+m+n)V^f/n(1+m)$.

virtually unchanged.

We note that the solution values of all the endogenous variables are strictly interior for all $t, t^* \in [0, t_n]$.

2.2 *Global efficiency and gains from cooperation*

We define global efficiency as the situation where the static joint welfare of the two countries, $W + W^*$, is maximized in each time period. This approach is common in the literature and natural for our case since the two countries are symmetric.[22]

With $c_m > c_n$, global efficiency is achieved if and only if free trade is implemented in each time period. A formal proof of this is given in Appendix A2. The intuition for this is simple. Starting at free trade, a strictly positive tariff by home shifts production from the efficient foreign-firms to inefficient home-firms producing good X which lowers world welfare. Also, the total world production of good X falls which lowers world welfare further since local price of good X and hence its marginal utility is strictly higher than the marginal cost of production in the two countries. Thus, symmetrically lowering home's and foreign's tariff from the static Nash equilibrium level towards zero increases the welfare of both the countries.

The intuition for gains from cooperation can be noted from the structure of externalities across countries from unilateral policies which is captured in the next equation:

$$\partial W^* / \partial t = -V(-\partial p_x^w / \partial t) + (p_x^w - c_n) \partial V / \partial t$$

The partial derivatives here indicate that foreign's tariff is held fixed. RHS of the previous equation is simply the loss in the producer surplus to foreign-exporters from home's tariff

[22] See Bagwell and Staiger (1990) for a similar approach.

when evaluated at the margin. The first term is the loss due to the adverse price movement while the second one is the loss due to reduction in the production of foreign's exportable and it strictly positive since, due to imperfect competition, $p_x^w > c_n$ so that output changes have a *first order effect* on total producer surplus and hence, national welfare, as discussed above.

With the above discussion in place, we now seek to explain how the Pareto gains from cooperation discussed above can be realized. To this end, we extend the model to allow for repeated interaction. In particular, we seek to explore how repeated interaction enables countries to lower protection from the levels that would prevail in the static environment. The relationship between import-volume and the achieved protection levels will be of special interest here.

To incorporate the dynamic elements we make two departures from the static model above. That is, we assume that the static model is repeated infinitely and that there are periodic shocks of the kind discussed in the following paragraph.

In this section we focus on symmetric shocks in each country's exportable good's sector. Specifically, we assume that, at the beginning of each period, "nature" assigns a non-negative value to c_n which is the unit and marginal cost of producing the exportable good for home and foreign. Let $F(c_n)$ denote the distribution function of c_n over the support $[\underline{c}_n, \bar{c}_n]$, $0 \leq \underline{c}_n < \bar{c}_n$ where $\underline{c}_n, \bar{c}_n$ satisfy Assumption A1. We assume that $F(.)$ is well defined, continuous, differentiable upto the necessary order and stationary over time so that c_n is independently and identically distributed (i.i.d.) across time periods. As stated above, each country seeks to maximize its national welfare in each period.[23]

We next introduce the two basic elements of repeated interaction: the "incentive to deviate" and the "threat of future punishment".

2.3 *Deviation payoffs*

Given the symmetric nature of the model, it is natural to focus on symmetric cooperative tariffs. That is, the cooperative agreement specifies the same tariff for each country which will be denoted by $t_c = t_c(c_n)$. Our final solution will feature $t_c < t_n$ and hence we will restrict our discussion to this case. We may also note that with i.i.d. shocks our model is stationary across time periods so that in any subgame perfect equilibria of the repeated game we have the same tariff function, $t_c(c_n)$, implemented in each time period. With this holding, we omit the time-period notations.[24]

Home's incentive to deviate is given by its (static) deviation payoff which is the change in its welfare when it (optimally) deviates from t_c to t_n and foreign's tariff is held fixed at t_c. This is equal to

$$\Omega(V^f, \mu^f, t_c) \equiv \int_{t_c}^{t_n} W'(V^f, \mu^f, t)dt \quad .....(3)$$

where $W'(.)$ is as in equation (2).

The explicit expression of $\Omega(V^f, \mu^f, t_c)$ is stated in Appendix A1 from which it can be checked that it is strictly decreasing and convex in t_c over the interval $[0, t_n)$. Further, $\Omega(V^f, \mu^f, t_n) = 0$ and the derivative of $\Omega(.)$ with respect to t_c at $t_c = t_n$ is equal to zero.[25]

[23] As in Bagwell and Staiger (1990), countries are not concerned with risk sharing in this setting since marginal utility of national income is unaffected by the shocks here and elsewhere in the paper. For more details on this point, see, Bagwell and Staiger, p. 781, footnote 6.

[24] For a similar result, see, for example, Bagwell and Staiger (1990).

[25] See Appendix A1 for more details on this point.

The dynamics of the deviation payoff with respect to c_n can be derived from the identity in (3). Holding t_c fixed, differentiating $\Omega(.)$ with respect to c_n and using the Envelope theorem we get:

$$d\Omega(.)/dc_n = \int_{t_c}^{t_n} (-\partial p_x^w/\partial t) dV^f/dc_n + (\partial X_m/\partial t) d\mu^f/dc_n \; dt \quad ...(4)$$

The integrand in (4) is simply $\partial W'(V^f, \mu^f, t)/\partial c_n$ which captures the shift in home's marginal benefit function from protection due to a change in c_n.[26] The first term of the integrand defines our *terms-of-trade effect* and the second term defines the *mark-up effect,* as discussed in the introduction. Specifically, with all tariffs held fixed, a *lower* value of c_n leads to a surge in home's import-volume ($\partial V/\partial c_n = dV^f/dc_n < 0$ as stated in *Lemma* 1) which increases home's marginal benefit from protection and thus, its deviation payoff, for terms-of-trade related gains net of consumption and production distortion of the tariff. Next we note that the stated change in c_n also lowers home's equilibrium mark-up ($\partial \mu_x/\partial c_n = d\mu^f/dc_n > 0$ as in *Lemma* 1). With a lower mark-up, home's marginal benefit from protection and thus, its deviation payoff, falls. This constitutes the *mark-up effect* with respect to c_n and is captured by the second term of the integrand in (4). The direction of the overall change in the deviation payoff depends on the relative strengths of these two competing effects. It is important to note here that the change in the mark-up described here is completely driven by the underlying change in home's import volume. That is, changes in c_n affect the value of μ^f through the implied change in V^f only. This makes our results directly comparable to the ones in Bagwell and Staiger which are also completely driven by changes in trade-volumes.

Substituting for the terms in (4) we get that the *mark-up effect* dominates the *terms-*

[26] The partial derivative of $W'(.)$ with respect to c_n here implies that all tariffs are held fixed.

of-trade effect in absolute value so that $d\Omega(.)/dc_n > 0$ if and only if $n > (m+1)^2/m$. This situation yields a negative relationship between temporary surges in trade-volumes and the incentive to deviate.[27] The interpretation of previous inequality is simple. Holding m fixed, as n rises home's market power in trade $(-\partial p_x^w/\partial t)$ becomes smaller and approaches zero in the limit. Benefit to home from protectionist policy is then simply the expansion of its import-competing sector due to the positive mark-up. Thus, the *mark-up effect* dominates the *terms-of-trade effect* at sufficiently large values of n. The opposite holds when m rises for any fixed n. In this case, home's market power rises and approaches one in the limit. Simultaneously, its mark-up value approaches zero and becomes invariant to its tariff. Thus, the *terms-of-trade effect* is the dominant effect here.

Summarizing, we have shown above that a surge in import-volume stemming from a lower c_n can either increase or decrease the incentive to deviate depending upon the relative strength of the two effects described above. We may infer from this that when the *mark-up effect* dominates then the incentive to deviate is smaller in periods of high import-volumes so that more liberal trade policy (lower tariffs) can be sustained in equilibrium.

2.4 *Threat of future punishment*

The threat of future punishment which sustains cooperation between countries is given by the present discounted value of the expected loss in welfare from a trade war relative to cooperation. This is equal to

$$\omega = \omega(t_c) \equiv (\delta/(1-\delta))E[W(., c_n, t_c, t_c) - W(., c_n, t_n, t_n)]$$

[27] We note that the deviation payoff of the foreign country is also given by the same $\Omega(.)$ function so that this property of holds for both the countries.

$$= \frac{\delta}{1-\delta} E\left[\frac{\{(1+m)^2+nm\}\beta V^f - nm(\alpha - c_m)}{\beta(1+m)(1+m+n)}(t_n - t_c) + \frac{n^2(t_n^2 - t_c^2)}{2\beta(1+m+n)^2}\right] \quad ....(5)$$

where E is the expectations operator over c_n and, $\delta \in (0,1)$, is the common discount rate of each country. It is direct to verify that the first term inside the square bracket is strictly positive with $t_c < t_n$ and $\omega(t_c = t_n) = 0$. Since c_n is i.i.d. across time periods, ω is independent of the current value of c_n as well as t_c. The function $t_c(c_n)$ will affect ω, however, since the function's distributional characteristics influence the expected values in $\omega(.)$.

2.4 *Existence of the solution value of* t_c

A cooperative tariff function, $t_c(c_n)$, can be sustained as a subgame perfect equilibrium of the game if and only if

$$\Omega(V^f, \mu^f, t_c) \leq \omega(t_c), \forall c_n \qquad ......(6)$$

The inequality in (6) is the usual "no defection" condition or the "enforcement constraint". The subgame perfect equilibrium of the repeated game is simply the tariff function that maximizes $W + W^*$ subject to the constraint in (6). To prove the existence of a unique solution, we adopt the following procedure. Take any arbitrary and non-negative value of $\omega(.), \bar{\omega}$, and treat it as fixed initially. Now solve for the minimum value of t_c from (6). This is given by $t_c(c_n, \bar{\omega}) = max\{0, t_n - \sqrt{\bar{\omega}/\theta}\}$, $\theta \equiv \dfrac{n[n+2(1+m)^2]}{2\beta(1+m+n)^2}$. Using equation (5) we now compute $\omega(t_c(c_n, \bar{\omega})) \equiv \tilde{\omega}(\bar{\omega})$. Existence of a solution is proved by showing that $\exists \bar{\omega}$ such that $\tilde{\omega}(\bar{\omega}) = \bar{\omega}$. Using this fixed point solution value of $\bar{\omega}$, we get the equilibrium tariff function as $t_c(c_n, \bar{\omega})$. When multiple solutions exist we pick the highest value of $\bar{\omega}$ that satisfies the previous equality. It is trivial to note $\tilde{\omega}(0) = 0$. This constitutes one solution with each country playing its static Nash equilibrium tariff in each period.

However, we seek to explore if higher solution values of $\bar{\omega}$ exist so that $t_c(c_n) < t_n$ for at least some values of c_n. To this end, define the set $B(\bar{\omega}) \subseteq [\underline{c}, \bar{c}]$ such that $c_n \in B(\bar{\omega}) \Leftrightarrow \dfrac{(mn-(1+m)^2)c_n}{(n+2(1+m)^2)} \leq \sqrt{\bar{\omega}/\theta} - \dfrac{(1+2m)\alpha + m(m-n)c_m}{n+2(1+m)^2}$. From the $t_c(c_n, \bar{\omega})$ function it is direct to verify that $t_c(c_n, \bar{\omega}) = 0 \Leftrightarrow c_n \in B(\bar{\omega})$ and strictly positive otherwise. We may note here that $B(\bar{\omega})$ may be empty (null set) for some values of $\bar{\omega}$. Let $B^c(\bar{\omega})$ denote the complement of $B(\bar{\omega})$. With this in place we get $\tilde{\omega}(\bar{\omega})$ as:

$$\tilde{\omega}(\bar{\omega}) = \frac{\delta[(1+m)^2+mn]}{(1-\delta)(1+m)(1+m+n)} \left[\int^{B(\bar{\omega})} t_n V^f dF + \sqrt{\bar{\omega}/\theta} \int^{B^c(\bar{\omega})} V^f dF \right]$$

$$- \frac{\delta nm(\alpha - c_m)}{(1-\delta)\beta(1+m)(1+m+n)} \left[\int^{B(\bar{\omega})} t_n dF + \int^{B^c(\bar{\omega})} \sqrt{\bar{\omega}/\theta} dF \right]$$

$$+ \frac{\delta n^2}{(1-\delta)2\beta(1+m+n)^2} \left[\int^{B(\bar{\omega})} t_n^2 dF + \int^{B^c(\bar{\omega})} [2t_n\sqrt{\bar{\omega}/\theta} - \bar{\omega}/\theta] dF \right] \quad ....(7)$$

The first square bracket on RHS of equation (7) gives us $E(V^f(t_n - t_c))$, the second one is $E(t_n - t_c)$ and the third one is $E(t_n^2 - t_c^2)$.[28] It can be checked that $\tilde{\omega}(\bar{\omega}) > 0 \; \forall \bar{\omega} > 0$.

(a) Consider first the case when $\forall \bar{\omega} \geq max \; \theta t_n^2 \equiv \bar{\omega}_1$, where the maxima is taken over c_n. With this holding, we have that $t_c(c_n, \bar{\omega}) = 0$ and that $B(\bar{\omega}) = [\underline{c}, \bar{c}]$, $B^c(\bar{\omega}) = \emptyset$. Substituting these values in equation (7) we get the value of $\tilde{\omega}(\bar{\omega})$ which is independent of $\bar{\omega}$, strictly increasing in δ, approaches zero as δ tends to zero, and is arbitrarily large as δ approaches 1. These properties imply that $\forall \bar{\omega} \geq max \; \theta t_n^2$, we can find a unique value of δ such that $\tilde{\omega}(\bar{\omega}) = \bar{\omega}$. Since LHS of the previous equation is increasing in δ and its RHS is increasing in $\bar{\omega}$, we get that minimum value of δ, say δ_1, required here is given by the

[28] From the definition of $B(\bar{\omega})$ it is direct to verify that when $\bar{\omega} = 0$ then $B(\bar{\omega})$ is a null set and thus $\tilde{\omega}(0) = 0$ as stated above.

condition that $\tilde{\omega}(\bar{\omega}_1) = \bar{\omega}_1$. Thus, we have proved the existence of a unique solution with $t_c = 0$ when $\delta \geq \delta_1$, or equivalently, when the fixed point solution satisfies the condition that $\bar{\omega} \geq max\ \theta t_n^2$.

(b) Now consider the remaining case when $\delta < \delta_1$. As stated above, this implies that $\tilde{\omega}(\bar{\omega}_1) < \bar{\omega}_1$ and thus $\tilde{\omega}(\bar{\omega}) < \bar{\omega}$, $\forall \bar{\omega} \leq \bar{\omega}_1$. We have already stated above that $t_n > 0\ \forall c_n$ which implies that $\exists \bar{\omega} = \bar{\omega}_2$ such that $\forall \bar{\omega} \leq \bar{\omega}_2$, $t_c(c_n, \bar{\omega}) > 0\ \forall c_n$ and $B^c(\bar{\omega}) = [\underline{c}, \bar{c}]$, $B(\bar{\omega}) = \emptyset$. Substituting these restrictions in equation (6) it is simple to note that with primes denoting derivatives, $\omega'(0) = \infty$ and $\tilde{\omega}''(\bar{\omega}) < 0$ for all $\bar{\omega} \leq \bar{\omega}_2$. These properties imply that $\exists \bar{\omega} = \bar{\omega}_3$, with $0 < \bar{\omega}_3 \leq \bar{\omega}_2$ such that $\tilde{\omega}(\bar{\omega}_3) > \bar{\omega}_3$. The existence of a fixed point then follows from the previous inequality, $\tilde{\omega}(\bar{\omega}_1) < \bar{\omega}_1$ as stated above, and the fact that $\tilde{\omega}(\bar{\omega})$ is continuous in $\bar{\omega}$. With some tedious algebra it can be checked that $\tilde{\omega}''(\bar{\omega}) < 0\ \forall \bar{\omega} < \bar{\omega}_1$ and zero otherwise so that the strictly interior fixed point solution derived here is unique.[29] It is direct to verify that in this case ($\delta < \delta_1$) we have that $t_c(c_n) > 0$ over an interval of values of c_n. This completes the existence proof.

2.5 *Dynamic pattern of cooperation*

The pattern of managed trade can now be easily derived. Consider the case when $\delta < \delta_1$ and let $\hat{\omega}$ denote the fixed point solution as stated in the previous sub-section. We have noted above that with $\delta < \delta_1$ free trade is not subgame perfect in all states of the world (values of c_n). From the solution above it is evident that in this case there exists an interval of values of c_n over which the no-defection condition is binding. Pick any two values of c_n from this interval, say, c_{1n} and c_{2n} with $c_{1n} < c_{2n}$. We have that $t_c(c_{in}) = t_n(c_{in}) - \sqrt{\hat{\omega}/\theta}$ for $i = 1, 2$,

[29] This (unique) interior solution is in addition to the corner solution noted above where $\omega = 0$ and $t_c(c_n) = t_n$.

where $t_n(c_{in})$ is the value of t_n when $c_n = c_{in}$. Noting that $\hat{\omega}$ is independent of the current realization of c_n (that is, independent of c_{1n}, c_{2n}) and θ, by definition, is independent of c_n, it follows that $t_c(c_{1n}) < t_c(c_{2n})$ if and only if $t_n(c_{1n}) < t_n(c_{2n})$. From the solution value of t_n in the Appendix it is direct to verify that the previous two inequalities will hold if and only if $n > (1+m)^2/m$. From *Lemma* 1 we already know that $c_{1n} < c_{2n} \Rightarrow V^f(., c_{1n}) > V^f(., c_{2n})$.[30] This gives us our main result in the section that while a lower value of c_n leads to a surge in underlying trade-volume, however, it also leads to lower tariff along the equilibrium path of the dynamic game provided that δ is sufficiently small so that the no-defection condition is binding and that $n > (1+m)^2/m$.[31]

The intuition for the result can be easily discussed in terms of the *terms-of-trade effect* and *mark-up effect* described above. Briefly, with tariffs held fixed, a lower value of c_n leads to a surge in each country's import-volume. Through the *mark-up effect* this surge lowers the incentive to deviate while the *terms-of-trade effect* counters this by increasing the deviation payoff. The net effect of these two is to lower the deviation payoff if and only if the previous inequality holds. When this is the case and the no-defection condition is binding so that the equilibrium tariffs are sensitive to the movement in the deviation payoff, then we get our simple result that periods of abnormally high trade-volumes witness more cooperation (lower equilibrium tariffs). We may add here that this result is directly comparable to the one in Bagwell and Staiger since, as in their paper, the dynamics of managed trade here is driven completely by the initial surge in import-volume.[32]

[30] This inequality holds at any fixed tariffs and not just at the free trade import-volume.

[31] We may note here that it will suffice for our result here if the no-defection condition binds strictly at c_{2n} only so that $t_c(c_{2n}) > 0$.

[32] That is, there is no direct effect of a change in c_n on the deviation payoff. This point has already been

We now proceed to the next section where we consider some extensions of the model so far.

Section 3: Extensions

In this section we put forward some extensions of the results derived above. We focus squarely on tariffs alone in sub-sections 3.1 to 3.3 while in 3.4 we allow for export policies in addition to tariffs. Throughout the section we will assume that the subgame perfect equilibrium of the repeated game exists and that δ is sufficiently small so that the no-defection condition is binding.[33]

3.1 *Shocks in import-competing sectors*

Consider i.i.d. shocks in the value of c_m which is the unit and marginal cost of producing the importable in each country. Since the static game here is the same as in section 2, global efficiency requires free trade and, the deviation payoff is given by the same $\Omega(.)$ function as above.

Holding t_c constant, using Envelope theorem and differentiating we get:

$$\frac{d\Omega(.)}{dc_m} = \int_{t_c}^{t_n} \frac{-\partial p_x^w}{\partial t}\frac{dV^f}{dc_m} + \frac{\partial X_m}{\partial t}\left[\frac{\partial \mu^f}{\partial V^f}\frac{dV^f}{dc_m} + \frac{\partial \mu^f}{\partial c_m}\right] dt$$

Interpreting the equation we note that since $t_n > t_c$, $\Omega(.)$ is increasing in c_m if and only if the integrand is positive. The first term of the integrand is the *terms-of-trade effect* with respect to c_m and is strictly positive since $dV^f/dc_m > 0$ (*Lemma* 1) This increases home's deviation payoff. The second term is the *mark-up effect* here and it is strictly negative which

discussed above.

[33] For parameter values when this does not hold we get free trade as the equilibrium outcome so that the issue of the dynamic structure of managed trade is irrelevant.

is evident from *Lemma* 1. It is slightly different from the one with shocks in c_n because, unlike c_n, changes in c_m have a direct effect on the deviation payoff also (i.e. the $\partial\mu^f/\partial c_m$ term). It can be checked that the integrand is negative if and only if the *mark-up effect* dominates the *terms-of-trade effect* in absolute value; or, equivalently, $\beta(1+m+n)^2 > nm[(1+m)^2 - mn]$. Thus, we get a similar result as above that a surge in import-volume due to a higher value of c_m implies a lower deviation payoff and lower equilibrium tariffs when the enforcement constraint is binding if and only if the previous inequality holds.

3.2 *Demand side shocks*

We now consider i.i.d. shocks in the value of α. That is, periodic shocks in each country's demand for the importable. The dynamic structure of the deviation payoff in α is given by

$$\frac{d\Omega(.)}{d\alpha} = \int_{t_c}^{t_n} (-\partial p_x^w/\partial t)dV^f/d\alpha + (\partial X_m/\partial t)\left[(\partial\mu^f/\partial V^f)dV^f/d\alpha + \partial\mu^f/\partial\alpha\right] dt$$

The first term in the integrand is the *terms-of-trade effect* while the second term is *mark-up effect* with respect to α. It is straightforward to check that both these terms are strictly positive. That is, holding tariffs fixed, a higher demand implies larger import-volume and higher mark-up for each country as stated in *Lemma* 1. Thus, the deviation payoff is strictly increasing in α. Consequently, we get that with demand side shocks, periods of high trade-volumes feature higher tariffs along the equilibrium path when the enforcement constraint is binding.

The contrasting results with supply and demand side shocks suggest while predicting the dynamic pattern of equilibrium tariffs vis-a-vis underlying import-volumes, it is important to draw a distinction between these two types of shocks.

3.3 *Interior solution conditions*

We assumed in the sections above that each country's export-firms are more efficient than the import-competing firms in the other country. That is, $c_n < c_m$. It can be checked that our main result about the dynamic structure of managed trade will continue to hold if this were replaced by a weaker assumption that: $\alpha > max\{c_n + (c_n - c_m)m, c_m - (c_n - c_m)n\}$ which is consistent with $c_n \geq c_m$. The main difference that would arise under this assumption is that global efficiency may require strictly positive tariffs. The intuition for this is that with $c_n > c_m$, a small (strictly) positive tariff will shift production away from inefficient export-firms to the efficient import-competing firms. While overall world output of the non-numeraire good will fall which will tend to lower global welfare as discussed above, however, the benefit from the shift from inefficient to efficient suppliers may increase global welfare on the net. However, when the enforcement issue is relevant so that the no-defection condition is binding then the pattern of managed trade is completely determined by the dynamic structure of the deviation payoff and global efficiency conditions are irrelevant then.[34]

3.4 *Export subsidies and taxes*

We complete our analysis with this last extension to include export policies. We maintain here that countries cooperate over tariffs alone and export subsidies (positive or negative) are set in a unilateral fashion. Also, assume that all our solution values are strictly interior as this will hold in our final equilibrium under Assumption A1.

Using home's welfare function stated above and treating t, t^*, e^* as fixed, we get home's best response (export) subsidy as equal to

[34] We note that if c_m is sufficiently smaller than c_n then global efficiency may require autarky. It can be checked that in this case the static Nash equilibrium will also feature autarky so that cooperation in trade policy is irrelevant.

$$e(t^*) \equiv (t_R - t^*)(1 + m - n)/2n$$

where t_R is home's prohibitive tariff when e, e^* are equal to zero. By symmetry, foreign's best response export subsidy is given by $e^*(t) = e(t)$.

Home's marginal benefit function with respect to t is given by

$$w_t = V(-\partial p_x^w/\partial t) + t\partial V/\partial t + \mu_x \partial X_m/\partial t$$

where all variables on RHS of the equation are evaluated at arbitrarily given e, e^*, t^* values.

Setting $w_t = 0$ and solving for t we get home's best response tariff as a function of e^*. Let this be denoted by $t(e^*)$.[35] It can be checked that this is independent of home's subsidy since markets for X, Y are segmented. Using these best response tariffs we can solve for the symmetric static Nash equilibrium values of t, e. Let these be denoted by $\bar{t}_n, e_n$ respectively. The expressions for these are stated in Appendix A3 from which it can be checked that the solution is unique, non-prohibitive and implies strictly positive values of all the endogenous variables.

Since there is no cooperation over subsidies, these must be at their unilaterally optimal levels in equilibrium. Thus, for the rest of the sub-section we set $e = e(t^*)$ and $e^* = e(t)$. Next we note a simple stability property which is that an exogenous change in the value of t implies that t and $t - e^*(t)$ change in the same direction.

Sources of gains from cooperation over tariffs are exactly the same as in the previous sections. Computing the change in global welfare due to a change in home's tariff we get:

$$\frac{dW + dW^*}{dt} = \frac{\partial(W + W^*)}{\partial t}\left[1 - \frac{de^*(t)}{dt}\right]$$

[35] Expression for $t(e^*)$ is stated in Appendix A3.

where the partial derivative on RHS of the previous equation implies that t^*, e, e^* are treated as fixed. From the stability property stated above and that $\partial(W + W^*)/\partial t < 0$ as noted in section 2, we have that global welfare is strictly decreasing in home's tariff. By symmetry, the same holds with respect to t^*. Thus, symmetrically lowering both the tariffs from their static Nash equilibrium levels improves the welfare of both the countries. This implies that cooperative effort seeks to implement the lowest possible symmetric tariff subject to the relevant no-defection condition.

The pattern of managed trade can now be easily inferred from the dynamic structure of the deviation payoff. To this end, consider i.i.d. shocks in the value of c_n as in section 2. Let $t_c(c_n)$ denote the symmetric subgame perfect equilibrium tariff function of the game. Since home's best response subsidy is independent of its own tariff, optimal deviation from an initial tariff agreement features home raising its tariff from t_c to $t(e_c)$ where $e_c = e(t_c)$ is foreign's subsidy level along the equilibrium path. Thus, home's deviation payoff is equal to $\int_{t_c}^{t(e_c)} w_t dt$.

Holding t_c fixed and using the Envelope theorem we get that

$$\frac{d}{dc_n} \int\limits_{t_c}^{t(e_c)} w_t dt = \int\limits_{t_c}^{t(e_c)} \frac{-\partial p_x^w}{\partial t} \left[\frac{\partial V}{\partial c_n} |_{e_c} + \frac{\partial V}{\partial e^*} \frac{\partial e^*}{\partial c_n} \right] + \frac{\partial X_m}{\partial t} \left[\frac{\partial \mu_x}{\partial c_n} |_{e_c} + \frac{\partial \mu_x}{\partial e^*} \frac{\partial e^*}{\partial c_n} \right] \, dt$$

Consider the previous equation. The first term of the integrand is the *terms-of-trade effect* here while the second one captures the *mark-up effect*. The only difference here from section 2 is that these effects now depend on the movement in the optimal subsidy. That is, holding t_c fixed, a change in c_n alters the best response subsidy by $\partial e^*(.)/\partial c_n$. This change has a *second order effect* only on home's welfare since the subsidy is set optimally to begin with. However, the revision in the subsidy alters home's marginal benefit function with respect to t (i.e. w_t function). Specifically, it changes the underlying import-volume by an amount equal to the second term in the first square bracket and the underlying mark-up in home's import-competing sector by an amount equal to the second term in the second square bracket. These changes in import-volume and mark-up are in addition to the direct effect of c_n on them which are captured by the first terms in the two square brackets, respectively, and are the same as in section 2. It can be easily checked that these two effects are competing effects so that the overall change in the deviation payoff depends on the relative strength of *terms-of-trade effect* and the *mark-up effect*. Substituting for the terms in previous equation we get that a *lower* value of c_n reduces the deviation payoff if and only if $n > (1+m)^2/m$ while at the same time each country observes an increase in its underlying import volume. This implies that in periods of abnormally high import-volumes will feature lower equilibrium tariffs when the previous inequality holds.[36]

This completes our discussion on the extensions of the model. Out basic result is that with imperfect competition, the pattern of managed trade depends on the dynamic structure of equilibrium price-cost mark-ups and, under the conditions highlighted above, periods of unusually high trade-volumes feature greater cooperation (lower tariffs).

Conclusion

The paper attempts to extend the work of Bagwell and Staiger (1990) to imperfectly competitive markets. We have shown that the pattern of managed trade with imperfect competition is qualitatively different from the one when all markets are perfectly competitive.

[36] It is simple to check that w_t is strictly decreasing in t so that the deviation payoff and the most cooperative symmetric tariff in the repeated game will move in the same direction when the enforcement constraint is binding.

This result was explained by the *mark-up effect* identified in the paper. We now put forward a simple generalization of the *mark-up effect* to other forms of domestic distortions and suggest some possible extensions of the model.

Consider an economy where all markets are perfectly competitive and there are output related positive external economies of scale in the import-competing sector. While private marginal cost and benefit must be equal to each other in equilibrium, however, absent policy intervention, the social marginal benefit from the production of the importable will not be equal to the social marginal cost in the sector. The argument is well known in the literature leading to a second-best role of import tariffs to correct for this distortion (the infant industry argument). The structure is similar to the presence of mark-ups in our model above with the difference that we need to appropriately define mark-ups here as "social mark-ups". Clearly, the size of these social mark-ups will depend on the underlying demand-supply conditions and, in particular, on the underlying trade-volume giving rise to the *mark-up effect* as identified in this paper. Implication of this for the theory of managed trade can be developed along the lines of this paper. We would like to mention here that it is difficult to say aprioi exactly what the direction of the relationship between trade-volumes and the size of these social mark-ups will be, however, this can be explored once the specifics of the model are known. We believe that, under appropriate conditions, the results of this paper can be replicated. It is evident from this other types of domestic distortions are likely to yield similar results.

Appendix

Appendix A1

(i) $X_m^f = m(\alpha - c_m - \beta V^f)/\beta(1+m)$, (ii) $p_x = \dfrac{\alpha + mc_m - \beta V^f}{1+m} + \dfrac{n(t-e^*)}{1+m+n}$.

(iii) Using equation (2) from section 1 set $\partial W/\partial t = 0$ and solve for t to get the solution value as

$$t_n = \frac{(1+m+n)/n}{n+2(1+m)^2}\left[(1+m)\beta V^f + mn\mu^f\right]$$

$$= \frac{(1+2m)\alpha + m(m-n)c_m + [mn-(1+m)^2]c_n}{n+2(1+m)^2}$$

(iv) Properties of $\Omega(.)$ function

From section 1, equation (2), we have that:

$$W'(V^f, \mu^f, t) = \frac{(1+m)\beta V^f + mn\mu^f}{\beta(1+m+n)} - \frac{n[n+2(1+m)^2]}{\beta(1+m+n)^2}t.$$

Using the previous equation, noting the definition of $\Omega(.)$ from section 2 and t_n from part (iii) above, we get that

$$\Omega(., t_c) = \frac{[(1+m)\beta V^f + mn\mu^f](t_n - t_c)}{\beta(1+m+n)} - \frac{n[n+2(1+m)^2](t_n^2 - t_c^2)}{2\beta(1+m+n)^2}$$

It is straightforward to note from this that $\Omega(.)$ is convex in t_c. Further, $d\Omega(.)/dt_c < 0$ $\forall t_c \in [0, t_n)$ and it is equal to zero at $t_c = t_n$. Lastly, $d\Omega(.)/dt_c > 0$ $\forall t_c \in (t_n, t_R]$, and $\Omega(., t_c = t_n) = 0$.

Appendix A2: Free trade is globally efficient

From section 2 we have that:$\partial(W+W^*)/\partial t = (p_x - c_m)\partial X/\partial t + (c_m - c_n)\partial V/\partial t$, where the partial derivatives indicate that foreign's tariff is held fixed. Note that both the terms on

RHS of the equation are strictly negative with $c_m > c_n$. Given the symmetric nature of the model, it follows that lowering tariffs symmetrically towards zero increases welfare of both the countries.

Q.E.D.

Appendix A3: Static Nash equilibrium values with export subsidies:

The best response tariff and subsidy for the home country, denoted by $t(e^*), e(t^*)$, respectively, are: $t(e^*) = t_n + \frac{(1+m)^2 - mn}{n + 2(1+m)^2} e^*$, where t_n is as above; $e(t^*) = (t_R - t^*)(1+m-n)/2n$. Solving the previous two equations simultaneously we get the symmetric static Nash equilibrium values of t, e, as equal to $\bar{t}_n, e_n$, respectively which are as follows: $\bar{t}_n = \lambda t_n + (1-\lambda)t_R$ where $\lambda \equiv \frac{2n}{2n + \lambda_1(1+m-n)}$, $\lambda_1 \equiv \frac{(1+m)^2 - mn}{n + 2(1+m)^2}$. It can be easily checked that $\lambda > 0$. For the export subsidy we have that: $e_n = (1+m-n)\lambda(t_R - t_n)/2n$. It can be easily checked that the Nash equilibrium values of tariffs and export subsidies imply that the volume of trade is strictly positive.

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