The Sequencing of Trade Liberalization in the Presence of Adjustment Costs

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I. Introduction

A common feature of trade agreements between countries is that the integration of markets proceeds in stages. The first stage of integration typically involves the elimination of tariffs on trade in manufactured goods. Once this is completed, the member countries often proceed to deeper forms of economic integration. Later stages of this process can involve the extension of market integration to include financial markets, the adoption of common policies to cover competition and intellectual property, and the development of supranational institutions. A prime example of this has been the evolution of the regional agreement in Europe from the European Union. For example, the Single Market initiative in the European Union in 1992 extended integration of markets far beyond the simple elimination of trade barriers between member countries that had been started in the Treaty of Rome. The process of complete financial market integration is still ongoing.[1] Evenett, Venables and Winters (2004) discuss the sequencing of liberalization in East Asia. A somewhat similar series of steps has also occurred in the WTO. Although complete integration of manufactured goods has not been achieved, integration in services, investment, and agricultural trade have only been undertaken after a substantial amount of liberalization on manufactured goods has been accomplished.

A natural question to ask is why the process of market integration evolves sequentially, with some forms of integration taking place prior to others. A model of sequential liberalization should be capable of answering two questions. The first is why the countries don't simply adopt all of the market opening reforms at once. If the reforms undertaken are truly socially desirable, a delay in implementing reforms will simply reduce the present value of returns generated from market liberalization. A second question is what factors determine which of the issues should be addressed first, and which postponed to the later stage

[1] A second aspect of sequencing is the addition of new countries to the agreement. This issue will not be addressed in this paper.

The approach taken in this paper is to analyze the role of adjustment costs in the trade liberalization process in providing an answer to these two questions. The analysis will be undertaken under the assumption that trade agreements lack international institutions to enforce compliance, and thus must be self-enforcing. The basic idea of this paper is that the presence of adjustment costs will make reforms most fragile in their early stages, since the costs are borne up front but the benefits are delayed. This will mean that the temptation to deviate from the agreement will be strongest in the early stages of the agreement. Adjustment costs are, however, something of a two-edged sword in the liberalization process. Once resources have been moved, adjustment costs will actually make it less likely that countries will deviate from the agreement in sectors that have already been liberalized.

It is shown in Section II of the paper that this feature of adjustment costs will that the minimum discount factor necessary to support liberalization with sequential liberalization is less than the one to support simultaneous liberalization when two countries are trying to liberalized two different sectors of economic activity. If both types of liberalization are sustainable, then liberalization should be simultaneous. However, if the discount factor lies between the minimum discount factor for simultaneous and sequential liberalization, then sequential liberalization will be observed. The intuition for the easier sustainability of sequential liberalization can be seen by considering the incentives of the countries at each stage of the process. At the first stage of the liberalization process, the countries liberalize sector 1. Although the countries are currently liberalizing only sector 1, the anticipation of future gains from liberalization in sector 2 are a benefit that makes it more likely that it will be worthwhile to liberalize sector 1 in period 1. In period 2, the countries proceed to liberalize sector 2. If a country reneges on the agreement at this point, it must incur adjustment costs of returning workers in the import-competing sector 1 who had departed in the previous period. These adjustment costs tent to lock in the gains from liberalization in sector 1 by reducing the return to deviation in period 2. An interesting feature of this approach is that it suggests that it may often be desirable to liberalize the sector with high adjustment costs first, as these adjustment costs will raise the cost of going back on the agreement at later stages.

Explaining the sequential nature of liberalization obviously bears similarity to the question of why tariff reductions under trade agreements tend to be phased in gradually, rather than being completely eliminated at the signing of the agreement. Staiger (1995) and Furusawa and Lai (1997) have shown that the existence of costs of moving resources between sectors can help to explain why self-enforcing trade agreements between countries may involve gradual reduction of tariffs.[2] The difference is that the literature on gradualism focuses on the benefits of delaying tariff reductions of a single good, whereas the analysis of the sequential liberalization in Section II involves the comparison of how liberalization in one sector affects the incentives to liberalize in the other sector. Thus, in the sequential analysis we can consider how differences across sectors in the level of adjustment costs, the elasticity of export supply schedules, and the degree of spillovers between sectors can affect the desirability and ordering of sequential liberalization.

The analysis of section II focuses on the case in which the government's policy choice is a discrete one: it chooses to either liberalize or protect in each of the sectors. For some policy choices such as competition policy or intellectual property rights it seems natural to focus on the discrete choice of whether or not to coordinate policy between the two countries. In other instances, such as where the policy choice involves the setting of tariffs in over two different classes of goods, it seems more natural to treat the policy choice of the government as a continuous variable. The question in this case is whether an optimal policy will involve gradual reduction in the tariffs in both sectors at the same time, or whether it would involve reduction in one sector followed by reduction in the other. Section III analyzes this question by deriving the optimal adjustment paths in a two sector version of the Furosawa and Lai

[2] Lockwood and Zissimos (2005) show that gradualism can arise when there is irreversibility of tariff reductions generated by the withdrawal of equivalent concessions rules of the WTO. Bond and Park (2002) show that gradualism can arise even in the absence of adjustment costs or irreversibility if the countries are asymmetric.

model. This provides insights on how the existence of liberalization in one sector affects the pace of liberalization in the other sector in the optimal policy. Section IV offers some concluding remarks.

II. Sequential Liberalization of Sectors

In this section we examine the benefits of market liberalization where there are two symmetric countries that are considering an agreement over two different sectors of economic activity. It will be assumed that the countries face a prisoner's dilemma with respect to their policy choice in each sector, so that non-cooperative policy choices by the two countries will lead to an outcome that is inefficient. The question that will be addressed is under what conditions simultaneous actions to coordinate policies in the two markets are preferred to a sequential process, with coordination of actions in one market preceeding the coordination of actions in the other market. There will be two key assumptions in this analysis. The first is that there are no outside parties to enforce agreements between the sovereign states, so that any agreement between the countries must be self-enforcing. The second is that each country faces an adjustment cost each time it changes a policy in its market.

A. Reciprocal Liberalization in Independent Markets

As a benchmark for comparison, we begin with the case in which the two policy issues faced by the countries are independent, in the sense that the payoffs to policy choices on one issue are not affected by the policy choice made in the other market. The two policy issues can be thought of as being the decision as to whether to liberalize trade in two different sectors in which the countries trade. To simplify, the countries are assumed to have only two policy choices in each sector: to liberalize (denoted by L), or to protect (P) the sector. Under the assumption of independence, the payoff to the home country in sector i will be $W_i(a_i, a_i^*)$, where a_i , $a_i^* \in \{L, P\}$ are the actions taken by the home and foreign countries respectively in sector i. Symmetry of the countries will impose the restriction that for any actions a, b $\in$ {L, P}, $W_i(a,b) = W_i^*(b,a)$. It is assumed that $W_i(L, a^*) < W_i(P, a^*)$ for $a^* \in \{L, P\}$, so that protection is a dominant strategy and $W_i(P,P)$ is the payoff in the one shot Nash equilibrium. However, $W_i(L,L) > W_i(P,P)$ so that countries would gain if they could commit to a policy of liberalization in each sector.

A natural example of this type of policy interaction would be one in which the sectors can each be thought of as representing a range of goods or services, with each country having a comparative advantage in a subset of the goods in that sector. For example, within the set of manufactured goods the existence of two way trade could arise from differences in factor endowments, differences in technologies, or the presence of product differentiation. Similar heterogeneity of interests and two way trade is likely to arise in other sets of sectors that might be considered, such as agricultural goods, services, or financial assets. Trade models of this type typically give rise to a prisoner's dilemma in tariff setting, because protection by one country will have a negative spillover effect on export interests in the other country. As has been emphasized by Bagwell and Staiger (2002, Chapter 2), terms of trade spillovers will provide a motivation for trade agreements in models in which governments weight import-competing interests more heavily as well as in those where governments are national welfare maximizers. The assumption of independence of the two sectors results form an assumption of independence of demand and supply between the two sectors. An example of this type will be pursued in more detail in Section III. It should be noted, however, that one of these sectors can also be interpreted as being another policy issues such as environmental policies, infrastructure investments or intellectual property rights on which the countries might coordinate their policies. All that is required is the presence of a prisoner's dilemma in the policy choices.[3]

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[3]A number of papers have addressed the linkage of trade policy with other issues. Ederington (2002) and Limao (2005) examine the potential gains from linking trade agreements with domestic policy and environmental policy, respectively, when the agreements are being sustained by repeated interactions. These papers do not consider the role of adjustment costs, so all agreements will be simultaneous. Bond (2005) examines the spillovers between trade and infrastructure agreements. The case of sequential agreements is considered, but the analysis does not use a repeated game framework and focuses on the effects of infrastructure investments on tariff bargaining.

Adjustment costs are introduced by assuming that a country faces a cost of c_i if it switches from a protectionist policy in sector i to a free trade policy. Similarly, an adjustment cost of d_i is incurred when switching from a free trade policy to a protectionist policy. These adjustment costs can be thought of as the cost of moving workers from one sector to the other, and could include retraining costs, job search costs, and the cost of moving from one location to another if the sectors are spatially separated. Note that in the case where there is a reversal of a previous trade liberalization, it would be reasonable to expect that $d_i < c_i$ because the flow of workers to the protected industries are likely to have lower training costs because they are returning to jobs previously held in that sector. Letting δ be the discount rate on payoffs received in the next period, it will be assumed that adjustment costs are sufficiently small that liberalization is still socially desirable if the sector is initially in a protectionist state, $W_i(L,L) - (1 - \delta)c_i > W_i(P,P)$. Simultaneous liberalization will always be preferred to sequential liberalization in this case if countries can write enforceable contracts, because postponing liberalization will only result in a reduction in the present value of gains from liberalization.

We begin the analysis of the sustainability of by examining the case of an agreement in which countries will follow an (L,L) policy in sector i, with a deviation by either country in sector i punished by a permanent reversion to the one shot Nash equilibrium (P,P) in that sector. This agreement will be self-enforcing if the present value of payoffs under the agreement exceeds the value obtained by deviating from the agreement, and then suffering the punishment the subsequent punishment. Due to the symmetry of the countries, it will be sufficient to check that the agreement is enforceable for the home country. Assuming that both countries are initially following a protectionist policy, each will incur c_i in the first period from following the agreement but would occur no adjustment cost if it deviates by failing to liberalize. For any period $t > 1$, each country will have already moved its resources out of the protected sector so that following the agreement will follow no adjustment cost but deviating will result in a cost of d_i. To check the incentive compatibility of the agreement, we first check the sustainability of an ongoing agreement for t > 1. The present value of continuing with the agreement is $W_i(L,L)/(1 - \delta)$, while the present value of deviating and returning to the protectionist policy is $W_i(P,L) - d_i + \delta W_i(P,P)/(1-\delta)$. The agreement will be sustainable if

$$\Gamma_i(\delta) \equiv \frac{W_i(L,L)}{1-\delta} - W_i(P,L) - \frac{\delta W_i(P,P)}{1-\delta} \geq -d_i \qquad \text{for } t > 1 \tag{1}$$

This condition is less stringent than the one obtained without adjustment costs (i.e. $\Gamma_i(\delta) \geq 0$), because the presence of adjustment costs reduces the returns to deviating. In contrast, the no deviation condition in the initial period will be more strict because countries incur adjustment costs of moving resources if they follow the agreement. An agreement covering sector i liberalization alone would be incentive compatible in the initial period if

$$\Gamma_i(\delta) \geq c_i \qquad \text{for } t = 1 \tag{2}$$

Thus, a liberalization agreement in market i will be sustainable if the payoff parameters in market i are such that (2) is satisfied. Since Γ_i continuous and increasing in δ on [0,1) with $\lim_{\delta \to 1}\Gamma_i(\delta) = \infty$, there will exist a critical discount factor δ_i^C such that (2) is satisfied for $\delta \geq \delta_i^C$. The presence of adjustment costs does not alter the familiar result that cooperation will be sustainable for δ sufficiently close to 1. The impact of adjustment costs is to create an asymmetry between the adjustment period and subsequent periods. The most difficult period for the agreement is the adjustment period to liberalization, when the payoff to the agreement is lowest. In subsequent periods the adjustment costs actually tend to cement the agreement in place by deterring deviation.

A simultaneous liberalization will be a situation in which the countries agree to liberalize both sectors 1 and 2 at the same time, with a deviation by a country in one or both sectors triggering a reversion to the one shot Nash equilibrium in both markets. Since punishment takes place in both markets, a country will find it optimal to deviate in both markets at once if it chooses to deviate. With simultaneous liberalization, countries incur adjustment costs in both markets under the agreement in period 1 and will incur adjustment costs in both markets if they choose to deviate for t > 1. Simultaneous liberalization of the two sectors will be sustainable if:

$$\sum_i \Gamma_i(\delta) \geq \sum_i c_i \qquad \text{for } t = 1$$
$$\sum_i \Gamma_i(\delta) \geq -\sum_i d_i \qquad \text{for } t > 1 \qquad \textbf{(3)}$$

As in the case of liberalization of individual markets, adjustment costs make liberalization more difficult to sustain in period 1 but facilitate liberalization in periods following the movement of resources out of the protected sector. Using the same argument as in the liberalization of individual markets, there will exist a critical discount factor δ_{Sim}^C such that simultaneous liberalization is sustainable for $\delta \geq \delta_{Sim}^C$.

If we choose the numbering of markets such that $\delta_1^C \leq \delta_2^C$, then $\delta_1^C \leq \delta_{Sim}^C \leq \delta_2^C$ because the requirement that (3) hold is less stringent than the requirement that (1) and (2) hold for both i. For $\delta \in [\delta_{Sim}^C , \delta_2^C)$ the simultaneous liberalization of sectors will be sustainable in situations where liberalization in sector 2 is not sustainable. This an example of the observation by Bernheim and Whinston (1990) that multimarket agreements can be useful for the purpose of sustaining cooperation between parties, because slack enforcement power in one market can be used to help sustain an agreement in the other market.

A sequential agreement is one in which the countries agree to liberalize market 1 in the first period and market 2 in the second period. The agreement will be enforced by strategies under which a deviation from this plan in any market in any period triggers a reversion to the one shot Nash equilibrium in both markets. This process will result in a sequence of payoffs $\{W_1(L,L) - c_1, W_1(L,L), W_1(L,L), ...\}$

in market 1 and a sequence of payoffs $\{W_2(P,P), W_2(L,L) - c_2, W_2(L,L), ...\}$ in market 2 under the agreement. Since the payoff from liberalization is delayed with sequential liberalization, simultaneous liberalization will be preferred to sequential liberalization if liberalization is sustainable in both cases. Therefore, the only reason that sequential liberalization might be preferred to simultaneous liberalization is because it is sustainable when simultaneous liberalization is not.

From periods 3 onward, the sequential agreement is identical to that of the simultaneous agreement, so the sustainability condition will coincide with those in (3). In period 2, sector 1 has already liberalized so there are no adjustment costs associated with the agreement, but adjustment costs would be incurred in sector 1 if a deviation occurs. In sector 2, adjustment costs arise under the agreement but not under a deviation. This yields the sustainability condition

$$\sum_i \Gamma_i(\delta) - c_i \geq -(c_1 + d_1) \qquad \text{for } t = 2 \tag{4}$$

This condition is less stringent than that under simultaneous liberalization for t = 1 in (3), because the fact that resources have already been moved in the liberalized sector is a deterrent to deviation. Letting $\tilde{\delta}_2$ denote the value at which (4) holds with equality, it follows that $\tilde{\delta}_2 < \delta_{Sim}{}^C$ for $c_1 + d_1 > 0$.

Adjustment costs in market 1 tend to lock in those gains, and thus make it less attractive to deviate when market 2 is liberalized.

In period 1, the present value of the return from the agreement is the return from the current liberalization in market 1, $W_1(L,L)/(1 - \delta) - c_1$, plus the return from future liberalization in market 2, $W_2(P,P) + \delta W_2(L,L)/(1 - \delta) - \delta c_2$. A first period deviation will result in the usual deviation in gain in market 1 , $W_1(P,L) + \delta W_1(P,P)/(1 - \delta)$. However, in market 2 the payoff if the country deviates is $W_2(P,P)/(1 - \delta)$ because liberalization in that market never takes place. The incentive compatibility condition in period 1 is thus

$$\Gamma_1 + \delta\left(\frac{W_2(L,L) - W_2(P,P)}{1-\delta} - c_2\right) \geq c_1 \qquad \text{for } t = 1 \tag{5}$$

The term in parentheses in (5) must be positive from the assumption that liberalization in market 2 is profitable when adjustment costs are taken into account. Even if liberalization in sector 1 does not satisfy the condition (2) for profitable deviation on its own, liberalization in sector 1 may be sustainable as part of a sequential liberalization process when the gains from future liberalization in sector 2 are taken into account. Note that this requires that the liberalization of market 2 be anticipated at the time that liberalization takes place in market 1. Using the definition of Γ_2, (5) can be rewritten as

$$\sum_i \left(\Gamma_i(\delta) - c_i\right) + \left[W_2(P,L) - W_2(L,L) + c_2(1-\delta)\right] \geq 0 \qquad \text{for } t = 1 \tag{6}$$

Since the expression in brackets is positive, a comparison of (6) with (3) shows that the incentive compatibility condition for the sequential agreement at t = 1 is less stringent than that for the simultaneous agreement. Letting $\tilde{\delta}_1$ denote the value at which (6) holds with equality, we have $\tilde{\delta}_1 < \delta_{Sim}^C$. Liberalization is easier to sustain in the sequential case in period 1 because there are benefits from deviation in only one market.

Combining the results for (5) and (6), sequential liberalization will be sustainable for $\delta \geq \delta_{Seq}^C = \max(\tilde{\delta}_1, \tilde{\delta}_2)$. Since $\delta_{Seq}^C < \delta_{Sim}^C$, there will exist discount factors for which liberalization of sectors 1 and 2 is sustainable if it is done sequentially, but not if it is done simultaneously. Sequential liberalization works because it uses the slack in the incentive constraint that is generated in one sector once a liberalization has occurred to facilitate liberalization in the other sector.

Equations (4) and (6) can also be used to say something about which sector should be liberalized first to obtain the lowest minimum discount factor for sequential liberalization. When sector 1 is being liberalized first, the period 2 incentive no deviation constraint will be the binding one if $c_1 + d_1 <$ $W_2(P,L) - W_2(L,L) + c_2(1 - \delta)$. If a similar condition is satisfied so that the period 2 constraint binds when sector 2 is liberalized first, then the sector with the higher level of adjustment costs should be liberalized first in order to obtain the lowest minimum discount factor for sequential liberalization.

The analysis has focused on the case in which there are no spillovers between the two sectors from the liberalization process. Although this assumption is useful for highlighting the role played by slack in the incentive constraint once resources have been move, it abstracts from the fact that in many cases liberalization in one sector will have a spillover on payoffs in the other sector. We now analyze some examples of spillovers between markets.

B. Congestion costs in Adjustment

An obvious case in which sequential liberalization may provide additional benefits occurs if there is congestion in the adjustment of workers, so that that adjustment costs in market i are greater if liberalization is also being undertaken in market j. Letting c_{12} be the adjustment cost that arises when 1 and 2 are liberalized simultaneously, congestions effects are introduced by assuming that $c_{12} > c_1 + c_2$.

One possibility that can arise is that sequential adjustment is socially optimal even in the case when the government can commit to its liberalization policy. This will occur if $c_{12} - c_1 - c_2 > W_2(L,L) -$ $W_2(P,P) - c_2 (1 - \delta) > 0$, which requires that saving in adjustment costs due to congestion exceed the cost of postponing liberalization in market 2 for one period. Even if congestion effects are not sufficiently large to make sequential adjustment socially optimal with commitment, they may still be large enough to affect whether simultaneous agreements are self-enforcing. In the presence of spillovers, the condition for simultaneous liberalization of markets to be self-enforcing in is

$$\sum_i \Gamma_i(\delta) \geq c_{12} \quad \text{for } t = 1 \qquad \textbf{(7)}$$

This condition is made more stringent by the existence of congestion in adjustment of sectors. On the other hand, conditions (4) and (6) for sequential agreements to be self-enforcing will be unaffected. Thus, the existence of congestion costs makes sequential liberalization more likely to be incentive compatible

C. Spillovers between Market Liberalization and Deviation Effects

A second type of spillover is the impact of liberalization in one sector on the payoffs in the other sector. Such cases will arise in trade liberalization when supplies and demands in one sector are affected by tariff policy in the other sector, as when products in one sector are used as inputs in the other sector or where the sectors compete for common inputs.

In this case home country welfare is no longer additively separable in the policies in the two sets of markets, so it is expressed as $W(a_1, a_1^*, a_2, a_2^*)$ where a_i (a_i^*) is the strategy followed by the home (foreign) country in market i . Positive spillovers from liberalization in market 1 will arise when liberalization in market 1 raises the return to liberalization in 2, W(L,L,L,L) - W(L,L,P,P) > W(P,P,L,L) - W(P,P,P,P). Negative spillovers will be said to arise if this inequality is reversed. In order to bound the magnitude of the spillovers between markets, it will be assumed that protectionism still represents a dominant strategy in each market so that W(P,P,P,P) is the home payoff in the Nash equilibrium of the one shot policy game. In addition, it is assumed that liberalization by both countries in sector i yields a higher payoff than protection by both countries sector i. These assumptions ensure that the spillovers are not so large as to alter the prisoner's dilemma in each market.

Since the effects of spillovers in adjustment costs were considered in the previous section, it will be assumed that the adjustment costs in each market are independent of the policy undertaken in the other market. Permanent liberalization in market 1 alone will yield a payoff of $W(L,L,P,P)/(1 - \delta) - c_1$, while simultaneous liberalization of both markets will yield a payoff $W(L,L,L,L)/(1-\delta) - \sum_i c_i$. If spillovers between markets are positive (negative), then socially profitable liberalization of the two markets individually is sufficient (necessary) for simultaneous liberalization of both markets to be profitable.

The primary difference between spillovers in the payoff to liberalization and spillovers in adjustment cost are that the former have a permanent effect on the payoff to liberalization while the latter have a transitory effect. One of the implications of this difference is that sequential liberalization may be socially preferred to simultaneous liberalization when there are spillovers in adjustment costs, sequential liberalization will never be strictly preferred to both simultaneous liberalization and single market liberalization in the presence of payoff spillovers. The average social payoff to sequential liberalization is $(1 - \delta)(W(L,L,P,P) - c_1) + \delta\,(W(L,L,L,L) - c_2(1 - \delta))$, which can be shown to be equal to a weighted average of the payoffs to liberalization of market 1 alone and simultaneous liberalization. Therefore, if governments can fully commit to liberalization the socially optimal payoff can always be achieved without the use of sequential liberalization when there are payoff spillovers. This results from the fact that if it pays to delay the liberalization of one market for one period, it will also pay to delay liberalization of the second market permanently.

Although sequential liberalization cannot be strictly socially optimal, it still could be a useful form of agreement if sequential liberalization is sustainable when simultaneous liberalization is not. To examine this possibility, we first note that the condition for simultaneous liberalization in the first period to be incentive compatible with spillovers is that

$$\Gamma_{12}(\delta) \equiv \frac{W(L,L,L,L)}{1-\delta} - W(P,L,P,L) - \frac{\delta W(P,P,P,P)}{1-\delta} \geq \sum_i c_i \qquad \text{for } t = 1$$

$$\Gamma_{12} \geq -\sum_i d_i \qquad \text{for } t > 1 \tag{8}$$

As in the previous cases considered, to examine whether a simultaneous liberalization is sustainable it is sufficient to test the no deviation constraint in the first period. [4]

Using an argument similar to that for the case where markets are independent, the sustainability conditions for sequential liberalization will be

$$\Gamma_{12}(\delta) \geq c_2 - d_1 \qquad \text{for } t = 2$$

$$\Gamma_1(\delta) - c_1 + \delta\left(\frac{W(L,L,L,L) - W(L,L,P,P)}{1-\delta} - c_2\right) \geq 0 \quad \text{for } t = 1 \tag{9}$$

As in the case without spillovers, the sustainability condition for sequential liberalization at t = 2 is less stringent than that for simultaneous liberalization for $c_1 + d_1 > 0$ because of the fact that resources from sector 1 have already moved out of the import-competing sector. The existence of spillovers does not affect the comparison of (8) and (9), because both sectors have been liberalized in the second period under either simultaneous or sequential liberalization. In the condition for first period liberalization, $\Gamma_1 \equiv W(L,L,P,P)/(1-\delta) - W(P,L,P,P) - \delta W(P,P,P,P)/(1-\delta)$ is the difference between the agreement payoff and the deviation payoff if market 1 is liberalized alone. The second expression in parentheses is the social gain from liberalizing sector two in the second period, given that market 1 is already liberalized. As in (5) for the independent sectors case, (9) shows that sequential liberalization relaxes the no deviation constraint relative to that of the single sector case by holding out the promise of gains from future liberalization.

Comparing (8) and (9) for t = 1, it can be seen that the condition for sequential liberalization to

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[4]Note that another form of simultaneous liberalization is possible if there are separate agreements covering the two sectors, with deviations in one sector resulting only in punishment in that sector. If decisions on policy in the respective sectors delegated to independent agencies that do not coordinate their policy making, then the sustainability condition requires checking that the policy maker in sector i does not want to deviate in sector i (taking as given that there will be no deviation in sector j). As has been pointed out by Spagnola (2001), the use of separate agreements may be attractive in cases where deviation in one market raises the returns to deviation in the other market. Considering this possibility would require defining payoffs for the individual decision-making units, and is not pursued here.

be incentive compatible will be less stringent than the condition for simultaneous liberalization if simultaneous liberalization if

$$\begin{aligned}&\left(W(P,L,P,L) - W(P,L,L,L)\right) + \left(W(P,L,L,L) - W(L,L,L,L)\right)\\&- \left(W(P,L,P,P) - W(L,L,P,P)\right) + (1-\delta)c_2 \geq 0\end{aligned} \qquad \textbf{(10)}$$

The first term in parentheses is the gain from deviation in market 2, given that a deviation is occurring in market 1, which must be positive. The next two terms in parentheses are the difference in the gain to deviation in market 1 between the case in which there is liberalization in market 2 and where there is no liberalization in market 2. In the case of independent markets, this effect was zero. With market spillovers, sequential liberalization is more likely to be attractive when the return to deviation 1 is higher when market 2 has also been liberalized.

Complementarity between trade liberalization and other policies is sometimes cited as a reason for the sequential nature of trade liberalization, with the argument being that successful completion of trade liberalization makes the returns to liberalizing other policies greater. Such a linkage does not arise here, because the spillovers are assumed to be permanent and fully anticipated. The potential role for complementarities to favor sequential agreements in this setting arises from the possibility that simultaneous liberalization of two sectors makes deviation much more attractive.

III. Trade Liberalization: Discrete and Continuous Liberalization

We now turn to a specific example involving trade liberalization in two sectors in the presence of adjustment costs. This model is first used to link the gains from sequential to specific parameters of a trade model. The analysis is then extended to allow for gradual reduction in tariffs in individual sectors as well as using sequential liberalization. This allows a comparison of the benefits of smoothing adjustment costs by using gradual adjustment both sectors as compared to adjusting the sectors sequentially.

A. A Model of Tariff Reduction in 2 Sectors

In this section we extend a trade model that has been utilized by Furosawa and Lai (1997) to study the gradual elimination of tariffs in the presence of adjustment costs. As in the previous section, there will be two sectors that can potentially be liberalized by symmetric countries. Each set of markets i consists of a home country export good, denoted Xi, and a home country import good, Mi, for $i \in \{1,2\}$. In addition, there is a numeraire good 0. Preferences of consumers are described by the quasi-linear utility function $U = \sum_{i=1,2} \sum_{j=X,M} \left(a_i D_{ji} - \frac{b_i}{2} D_{ji}^2 + \right) + D_0$, which generates identical linear demand curves

$D_{ji} = (a_i - p_{ji})/b_i$ for the importable and exportable good in market i. The indirect utility function will be $V = \sum_{j=X,M} \sum_{i=1,2} \frac{(a_i - p_{ji})^2}{2b_i} + Y$, where Y is household disposable income.

The supply of the home exportable in sector i is $2e_i$, where e_i denotes the level of a sector specific skilled labor that is assumed to be immobile. The export supply function for the home exportable in sector i will then be $Q_{Xi} = (2b_i e_i - a_i + p_{Xi})/b_i$, where p_{Xi} is the price of the home exportable in sector i. The importable in sector i is produced using labor that is mobile between the imported good and the numeraire, with one unit of labor being able to produce one unit of either the importable in i or the numeraire. Adjustment costs are introduced by assuming that the movement of a unit of labor from the importable in sector i to the numeraire sector costs α_i units of the numeraire good, and moving a unit of labor from the numeraire sector to the importable good in sector i costs β_i units of the numeraire good. The analysis can be substantially simplified if it is assumed that adjustment costs are subsidized by the government, so that the wage of a workers must equal 1 in the importable sector if production is to take place.[5] The demand for home country labor to produce good i, given the assumption of one unit of home labor per unit of output, is equal to the difference between home demand and foreign export supply. Under the foreign assumption of symmetry between home and foreign countries, foreign export supply will be $Q_{Mi}^* = (2b_ie_i - a_i + p_{Mi} - \tau_i)/b_i$, where τ_i is the home country specific tariff imposed in sector i. The demand for home labor in the importable sector will be the difference between home demand for the importable and foreign export supply, $L^d_{Mi} = (2(a_i - b_ie_i - p_{Mi}) + \tau_i)/b_i$. It will be assumed that $a_i \in (1 + b_ie_i, 1 + 2b_ie_i)$, which ensures that imports and home employment are positive at free trade and that the price of the importable good will equal 1. Foreign suppliers receive a price of $1 - \tau_i$, and tariff revenue will be $\tau_i (2b_ie_i - a_i + 1 - \tau_i)/b_i$. A change in the tariff of amount $\Delta\tau_i$ will change employment by an amount $\Delta\tau_i/b_i$, which will result in adjustment costs of $\beta_i\Delta\tau_i/b_i$ if $\Delta\tau_i > 0$ and $-\alpha_i\Delta\tau_i/b_i$ if $\Delta\tau_i < 0$.

Disposable income will equal the sum of factor incomes less lump sum taxes paid to the government, which is the difference between adjustment costs payments to workers that move and tariff revenue. Letting $\bar{L}$ denote the endowment of labor, disposable income will be

$$Y = \bar{L} + \sum_i 2(1 - \tau_i^*)\, e_i + \sum_i \tau_i\, (2b_ie_i - a_i + 1 - \tau_i) + \max\left[-\alpha_i\, \Delta\tau_i, \beta_i\Delta\tau_i\right]/\beta_i \qquad \textbf{(11)}$$

Substituting this expression into the indirect utility function, home welfare can be expressed as a function of current period import tariffs from each country and the previous period home import tariffs

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[5]If workers pay the adjustment costs, wages could be below those in the numeraire sector and not induce movement of labor, as long as they do not fall below $1 - \alpha_i(1 - \delta)$. Similarly, the wage could also exceed the numeraire sector wage without inducing labor movement as long as it is less than $1 + \beta_i(1 - \delta)$. This possibility substantially complicates the presentation.

$$V(\tau_{1t},\tau_{2t},\tau^*_{1t},\tau^*_{2t},\tau^0_{1,t-1},\tau^0_{2,t-1}) \equiv \sum_i \left[V_{Mi}(\tau_i) + V_{Xi}(\tau^*_i) + \bar{L} + A(\tau_{i,t},\tau_{i,t-1}) \right]$$

$$V_{Xi}(\tau^*_{it}) = 2e_i(1-\tau^*_{it}) + \frac{(a_i - 1 + \tau^*_{it})^2}{2b_i} \qquad V_{Mi}(\tau_{it}) = \frac{(a_i - 1)^2}{2b_i} + \frac{\tau_{it}(2e_i - a + 1 - \tau_{it})}{2b_i} \tag{12}$$

$$A(\tau_{i,t},\tau_{i,t-1}) = \max\left(-\alpha_i(\tau_{it} - \tau_{i,t-1}), \beta_i(\tau_{it} - \tau_{i,t-1}) \right)/b_i$$

The function V_{Mi} is the surplus associated with import good i, which is the sum of consumer surplus and tariff revenue from good i. Since the domestic price is invariant to the tariff policy, choosing the domestic tariff to maximize domestic welfare is equivalent to maximizing tariff revenue. The tariff revenue function will be strictly concave in τ_i. V_{Xi} is the surplus from the export sector, which will be decreasing and convex in the foreign country export tariff. The payoff to the home country (excluding adjustment costs) from a symmetric trade agreement at τ_i is $V_{Xi}(\tau_i) + V_{Mi}(\tau_i)$, with $V'_{Mi}(\tau_i) + V_{Xi}(\tau_i) = -\tau_i/b_i$. The benefits to mutual tariff reduction are proportional to the level of the tariff.

This model represents the type of prisoner's dilemma in trade policy with independence of trade policy effects across sectors that was discussed in the Section IIA. We begin by characterizing the Nash equilibrium tariffs and the efficient tariffs in this model. Due to the separability of the objective function (13), the optimal tariff maximizes $\sum_{s=t}^{\infty} \left[V_{Mi}(\tau_{i,s}) - \text{Max}\left(-\alpha_i(\tau_{i,s} - \tau_{i,s-1}), \beta_i(\tau_{i,s} - \tau_{i,s-1}) \right)/b_i) \right] \delta^{s-t}$, which is the discounted surplus in the import sector i less adjustment costs. It can be shown that for initial values of the tariff $\tau_{i,0} \in [0, \tau_i^N \equiv (2b_ie_i - a + 1 - \beta_i(1-\delta))/2]$, the solution to this problem satisfies $V'_{Mi}(\tau_{i,t}) + \beta_i(1-\delta)/b_i = 0$, yielding $\tau_{i,t} = \tau_i^N$ for $t > 0$.[6] Since this tariff represents the dominant strategy

[6]This problem can be formulated as a dynamic programming problem, $J(\tau_i) = \max_{y_i} V_{Mi}(y_i) - A(y_i - \tau_i) + \delta J(y_i)$. The fact that A is not differentiable at 0 means that there will be 3 ranges for the solution for the optimal tariff, depending on the initial value. If $\tau_i \le \tau_i^N$, then $y_i = \tau_i^N$ will satisfy the necessary conditions for choice y_i. For $\tau_i \ge (2b_ie_i - a + 1 + \alpha_i(1-\delta))/2$, the necessary conditions for choice of y_i requires that $V'_{Mi}(y_i) - \alpha_i(1-\delta)/b_i$

for each country, it will be the tariff rate in the one shot Nash equilibrium.

The efficient tariff for a trade agreement maximizes

$$\sum_{s=t}^{\infty} \left[V_{Mi}(\tau_{i,s}) + V_{Xi}(\tau_{i,s}) - \text{Max}\left(-\alpha_i(\tau_{i,s} - \tau_{i,s-1}), \beta_i(\tau_{i,s} - \tau_{i,s-1})\right)/b_i)\right]\delta^{s-t} \quad \textbf{(13)}$$

It is straightforward to show that with constant marginal adjustment costs as in this model, the efficient agreement will be one which results in an immediate jump to the efficient tariff, $\hat{\tau}_i = \alpha_i(1 - \delta)$, for $\tau_{i,0} \geq \hat{\tau}_i$. This is illustrated in Figure 1, which shows sectoral iso-welfare contours $W^2 > W^1 > W^0$ for the home country from symmetric agreements in which the initial tariff is τ_0 (where the sectoral subscript has been dropped) and the subsequent tariffs are constant at $\tau_{,t} = y$ for $t \geq 1$. The presence of adjustment costs means that the iso-welfare contours have a kink at $y = \tau_0$. For $y < \tau_0$, the slope of an iso-welfare contour in Figure 1 will be $\alpha(1 - \delta)/(\alpha(1 - \delta) - y) < 0$. For $y > \tau_0$, the slope will be $\beta(1 - \delta)/(\beta(1 - \delta) + y) > 0$. For $\tau_0 \geq \hat{\tau}$ the optimal policy is to jump to $\hat{\tau}$ for all future periods, while for $\tau_0 < \hat{\tau}$ the optimal policy is to remain at τ_0 forever.[7]

For the case in which agreements must be self-enforcing, the analysis of the previous section can be applied to derive conditions under which a trade agreement that provides immediate liberalization to the efficient tariffs can be supported by the threat of reversion to the one shot Nash equilibrium in both markets. Letting $W_i(L,L) = V_{Mi}(\hat{\tau}_i) + V_{Xi}(\hat{\tau}_i)$, $W_i(P,P) = V_{Mi}(\tau_i^N) + V_{Xi}(\tau_i^N)$, $W_i(P,L) = V_{Mi}(\tau_i^N) +$

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which will be satisfied at $y_i = (2b_ie_i - a + 1 + \alpha_i(1 - \delta))/2$. For $\tau_i \in [\tau_i^N, (2b_ie_i - a + 1 + \alpha_i(1 - \delta))/2]$, the optimal policy is to set $y_i = \tau_i$. Since initial tariffs exceeding τ_i^N would not be chosen under any trade agreement, the discussion in the text focuses on $\tau_{i,0} < \tau_i^N$.

[7] The efficient tariff is obtained in a similar fashion to the optimal tariff. The tariff $\alpha_i(1 - \delta)$ is efficient for initial tariffs exceeding $\alpha_i(1 - \delta)$. For $\tau_i < \alpha_i(1 - \delta)$, the efficient tariff is τ_i. The discussion in the text will be limited to tariffs in the interval $[\alpha_i(1 - \delta), \tau_i^N]$, for which the efficient and optimal tariffs will be the ones defined in the text. The efficient tariff here exceeds 0 for $\alpha > 0$ because of the assumption that the government pays adjustment costs. There will be more than the socially optimal amount of labor movement in response to $\tau_i = 0$ for $\alpha_i > 0$, so the optimal tariff will exceed 0.

$V_{Xi}(\hat{\tau}_i)$, $c_i = \alpha_i(\tau_i^N - \hat{\tau}_i)/b_i$, and $d_i = \beta_i(\tau_i^N - \hat{\tau}_i)/b_i$, the minimum discount factor for immediate and simultaneous liberalization to be supportable can be derived using (3). Similarly, the minimum discount factor for the case of sequential liberalization can be obtained from (4) and (6).[8]

Table 1 illustrates several examples to illustrate how the parameters of the model influence the attractiveness of simultaneous and sequential liberalization. In case 1, the two sectors differ only in that sector 2 has a higher cost of moving workers out of the import-competing sector. As a result of the higher adjustment costs in sector 2, the minimum discount factor in sector 2 will be higher than that in sector 1 if each sector were to be liberalized independently. Simultaneous liberalization of the two sectors results in a minimum discount factor lying between that for the two sectors individually, since slack enforcement power in market 1 can be used to sustain liberalization in sector 2. Sequential liberalization results in a lower minimum discount factor than that for simultaneous liberalization, and is most likely to be sustainable when it is sector 2 that is liberalized first. An interesting feature of this example is that sequential liberalization is easier to sustain when the sector where cooperation is more difficult to sustain (i.e. has a higher minimum discount factor) is liberalized first. This is due to the fact that sequential liberalization in period 2 is easier to sustain compared to simultaneous liberalization when adjustment costs in the sector liberalized in period 1 are higher. In this example, it is the period 2 minimum discount factor that is the binding one for sustaining sequential liberalization. Case 2 provides an example where the only difference between sectors is that the adjustment cost of moving resources back into the import-competing sector in the event of deviation is higher in sector 2. The results in this case are very similar to Case 1, in that sequential liberalization is easier to sustain if it is the sector with the higher level of adjustment costs is liberalized first.

[8]Note that since the efficient tariffs and deviation tariffs both depend on δ, the current payoffs will also depend on δ, in contrast to the assumptions of Section II. However, this effect is relatively small and does not alter the conclusion that liberalization is sustainable for δ sufficiently high.

Case 3 assumes identical adjustment costs in the two sectors, but that the export supply schedule is more elastic in sector 1. This results in a higher in a higher optimal tariff in sector 2, $\tau_2^N = .8 > \tau_1^N = .2$. If liberalization were undertaken on the sectors individually, the minimum discount factor for sector 2 is lower than that for sector 1. Although the benefits to deviating from an efficient trade agreement are higher in sector 2, the Nash equilibrium payoff is lower. The latter effect dominates in this example with linear demand, making liberalization harder to sustain in the sector with the lower initial Nash equilibrium tariff. In this case sequential liberalization is more likely to be sustainable if sector 2 is liberalized first. This example provides a contrast with the previous exampes, where the minimum discount factor under sequential liberalization was lower if it was the sector with the higher minimum discount factor that was liberalized first. The reason for this is that with similar adjustment cost per worker, the total adjustment costs are higher in the sector that has the higher optimal tariff.

B. Gradual Liberalization

We now relax the assumption that policy choices must be discrete and consider the possibility that countries can choose tariff paths $\{\tau_{it}\}$ for each sector i. It will be assumed that the sectors are liberalized jointly, so that a deviation from the agreed tariff path in either sector will trigger permanent reversion to the one shot Nash equilibrium in both sectors. This general framework allows for the consideration of several types of tariff policies. A simultaneous and immediate liberalization policy would be one in which the efficient agreement moved in the first period from τ_i^N to $\hat{\tau}_i$ in each sector i. A sequential liberalization policy would be one in which the tariff is reduced from τ_1^N to $\hat{\tau}_1$ in one or more steps in sector 1 followed by a reduction from τ_2^N to $\hat{\tau}_2$ in subsequent periods. A particular interest here is the interaction between tariff reductions in the two markets that are created by the no deviation constraint, since the payoffs in the indiviudal markets are independent of the liberalization decisions taken in the other market.

A country that deviates from a sequence of tariffs $\{\tau_{i,1}, \tau_{i,2},....\}$ in sector i for i = 1,2 at time t will choose the optimal tariff in each market, and then receive the one shot Nash equilibrium payoff in all subsequent periods. The payoff from a deviation at time t from an agreement that specifies a tariff pair $\{\tau_{it}, \tau_{i,t-1}\}$ will be

$$\Psi_i(\tau_{i,t},\tau_{i,t-1}) = V_{Mi}(\tau_i^N) + V_{Xi}(\tau_{i,t}) - A_i(\tau_i^N,\tau_{i,t-1}) + \frac{\delta\left(V_{Mi}(\tau_i^N) + V_{Xi}(\tau_i^N)\right)}{1-\delta} \quad \textbf{(14)}$$

If $\tau_{i,t-1} < \tau_i^N$, a deviation will result in adjustment costs of $\beta_i(\tau_i^N - \tau_{i,t-1})/b_i$ to move workers back to the importable sector, so $\partial\Psi_i/\partial\tau_{i,t-1} = \beta_i/b_i$. A lower level of the tariff in the previous period makes deviation less attractive, because it means a lower level of employment in the importable sector entering the period.

The analysis of the previous section established that the existence of a minimum discount factor δ_{Sim}^C such that the efficient trade agreement is sustainable starting from initial tariffs $\{\tau_1^N, \tau_2^N\}$ in the two sectors for $\delta \geq \delta_{Sim}^C$. For $\delta < \delta_{Sim}^C$, an immediate jump to the efficient tariff level is not sustainable. However, the following result establishes the existence of welfare-improving trade agreements with constant tariffs that will be self-enforcing if δ is sufficiently large.

<u>Proposition 1:</u> If $\delta > \dfrac{2b_ie_i + 1 - a + 2\alpha + 3\beta - \left((2b_ie_i + 1 - a + 2\alpha + 3\beta)^2 - 4\beta(2\alpha + 2\beta)\right)^{.5}}{2\beta}$ for i = 1,2,

exists a tariff pair $\{y_1, y_2\}$ such that a trade agreement specifying $\tau_{i,t} = y_i$ for all $t \geq 1$ will be self-enforcing and strictly preferred to the Nash equilibrium. For t > 1, the no deviation constraint under this stationary agreement will be satisfied with strict inequality.

Proposition 1 is established by deriving a condition such that there exists $\gamma_i < \tau_i^N$ such that $(1 - \delta)$

$\Psi_i(\gamma_i,\tau_i^N) \leq V_{Xi}(\gamma_i) + V_{Mi}(\gamma_i) - (1 - \delta)\alpha_i(\tau_i^N - \gamma_i)$ as illustrated in Figure 1. The condition that a small tariff reduction in sector i be socially welfare improving, which requires $\alpha_i (1 - \delta) < \tau_i^N$, is necessary but not sufficient for such an agreement to exist. In the following period, the no deviation constraint will hold with strict equality because the average payoff from t = 2 onward is $V_{Xi}(\gamma_i) + V_{Mi}(\gamma_i)$, while the deviation payoff is $\Psi_i(\gamma_i,\gamma_i) < \Psi_i(\gamma_i,\tau_i^N)$. The reduced adjustment costs under the agreement and the greater adjustment costs from deviation both create slack in the no deviation constraint for t > 2. Since this result holds for each individually, it will also hold for joint agreements covering both sectors. As a result of this slack in the incentive constraint, it will be possible to undertake additional liberalization.

Proposition 1 established the existence of a feasible agreement that improved welfare. The problem of finding the tariff path that maximizes the welfare of the home country, subject to the no deviation constraint and the requirement that the home and foreign countries be treated symetrically, can be formulated as a dynamic programming problem. Letting $\Omega(\tau_1, \tau_2)$ denote the maximum payoff that can be obtained by the home country in a symmetric trade agreement in which the previous period sectoral import tariffs were τ_1 and τ_2, we have

$$\Omega(\tau_1,\tau_2) = \max_{y_1,y_2} V(y_1,y_2,y_1,y_2,\tau_1,\tau_2) + \delta\, \Omega(y_1,y_2)$$
$$\text{subject to } \Omega(\tau_1,\tau_2) \geq \sum_i \Psi_i(y_i,\tau_i) \qquad \textbf{(15)}$$

The functions V and Ψ in (15) are obtained from (12) and (14) respectively, and y_i denotes the current period tariff chosen for sector i.

Letting λ denote the multiplier associated with the no deviation constraint, the necessary condition for choice of y_i (assuming that $\tau_i > y_i$ and that Ω is differentiable) will be[9]

[9]When Ω is not differentiable, then the requirement is that left hand side of (16) be contained in the subgradient of Ω. This will be relevant at points where the tariff will remain constant, due to the lack of differentiability of the adjustment cost function at that point.

$$\frac{1}{\delta}\left(\frac{\alpha_i - y_i}{b_i} + \frac{\lambda}{1+\lambda}\left(\frac{2b_i e_i + 1 - a_i - \tau_i}{b_i} \right) \right) = -\frac{\partial \Omega}{\partial y_i} \quad \textbf{(16)}$$

The first term on the left hand side of (16) is the impact of an increase in the agreement tariff on current national welfare. This term has both a negative and a positive effect of a tariff increase: an increase in the tariff reduces the volume of trade, but it also saves on adjustment costs by reducing the amount of labor movement. The second term is the impact of an increase in the current tariff on the no deviation payoff, which will be negative because a higher tariff reduces the export sector payoff in the period that the deviation occurs. This effect relaxes the no deviation constraint. The term on the right hand side is the impact of an increase in the tariff on future national welfare, since the tariff plays the role of a state variable in the presence of adjustment costs. (16) thus requires that the sum of marginal current and future benefits of an increase in the tariff equal zero. The effect of the tariff on future welfare can be obtained by differentiating (16) with respect to τ_i, assuming that $\tau_i > y_i$, which yields

$$\frac{\partial \Omega}{\partial \tau_i} = -\frac{\alpha_i(1+\lambda) + \beta_i \lambda}{b_i} \quad \textbf{(17)}$$

An increase in the previous period tariff tends to reduce the payoff in subsequent periods for two reasons. First, a higher starting tariff raises the adjustment costs that must be incurred in future trade liberalization. Second, a higher tariff reduces the amount of adjustment costs that must be incurred if the country chooses to deviate. The latter effect will disappear as λ approaches 0.

Evaluating (17) at t+1 and substituting into (16) yields

$$\alpha_i (1-\delta) - \delta\, \lambda_{t+1}(\beta_i + \alpha_i) + \frac{\lambda_t}{1+\lambda_t}(2b_i e_i + 1 - a_i) - \left(\frac{1+2\lambda_t}{1+\lambda_t} \right) y_t = 0 \quad \textbf{(18)}$$

Since each sector faces common values of λ_t for all t in the case of joint liberalization, (18) can be used to illustrate how the parameters of individual sectors will affect the adjustment process. For example, suppose the two sectors differ only in the value of β_i, which means that the efficient tariff will be the same in both sectors. It follows from (18) that the tariff in the sector with the higher value of β will be lower as long as $\lambda_{t+1} > 0$. The sector with the higher adjustment cost for returning to the import-competing industry will have a lower tariff along the adjustment path, because the higher value of β deters deviation. If the sectors have the same adjustment costs but differ in the demand or endowment parameters, the sector with the higher non-cooperative tariff (i.e. greater value of $(2b_ie_i + 1 - a_i)$) will have a greater tariff along the adjustment path.

Further insight about the spillovers between sectors can be obtained by providing simulations for the optimal policies for two of the cases illustrated in Table 1.[10] Figure 2 shows the optimal paths for trade liberalization for Case 2 from Table 1 under two alternative assumptions. The separate liberalization solution is one where the two sectors are liberalized independently (i.e. a deviation in sector i is punished only by Nash reversion in sector i), which is obtained by solving (15) is solved separately for sectors 1 and 2) while the case of joint liberalization ties liberalization in the two sectors together. The discount parameter was chosen to be .6 for this case, which is below the value at which an immediate jump to free trade is sustainable under simultaneous liberalization but above the value at which an immediate jump can be sustained with sequential liberalization. Under separate liberalization the optimal tariff path involves a two step reduction in the tariff in sector 1 and a 3 step reduction sector 2. Sector 2, which has higher adjustment costs for workers returning to the import-competing good, has a higher minimum discount factor because the punishment payoff is less severe. Note that one of the

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[10]The mapping $T[f] = \max_{y_1,y_2} V(y_1,y_2,y_1,y_2,\tau_1,\tau_2) + \delta f(y_1,y_2)$ subject to $f(\tau_1,\tau_2) \geq \sum_i \Psi_i(y_i,\tau_i)$ is not a contraction, and as a result may have multiple fixed points. In particular, the payoff function reflecting the Nash payoffs will be a solution. In solving the problem, we want to find the largest f that is a fixed point of this problem. Since T is increasing in f, the solution can be found by choosing the unconstrained solution as the initial value of f and then iterating. This process will converge to the desired solution.

benefits of gradual tariff reduction is that both sectors eventually reach the first best tariff level, because the efficient tariff is not sustainable with a one step liberalization. With joint liberalization the efficient tariff is achieved in two steps in both sectors, with the pace of liberalization in sector 2 accelerated but that in sector 1 slowed down relative to separate liberalization. The reason for acceleration of the path in sector two with joint liberalization is that the high adjustment cost of returning workers to the import-competing good in sector 1 helps to cement liberalization and deter deviation for both sectors. This is similar to the reason why it was more efficient to have sector 2 move first in the case of sequential liberalization in Table 1.

Figure 3 shows a similar comparison of the paths for separate and joint liberalization in Case 3, where adjustment costs are identical across sectors, for $\delta = .5$. In this case the lower elasticity of demand in sector 2 leads to a higher Nash equilibrium tariff and a lower minimum discount factor as noted in Table 1. In the case of separate liberalization, sector 1 liberalizes in 4 steps and sector 2 in 3 steps. The discount factor is sufficiently low in this case that the efficient tariff is not sustainable in either sector. Joint liberalization has two effects on the time path of liberalization in the two sectors. The first effect is that the tariff falls more (less) rapidly in sector 1 (2) under joint liberalization. The second effect is that the steady state tariff in sector 1 (2) is higher (lower) under separate liberalization than with joint liberalization.

These results show how the paths of liberalization interact when two sectors are liberalized jointly. With joint liberalization, the sector with high adjustment costs on return movement of workers is likely to be liberalized more quickly in order to help deter future deviations. Note however that these interactions were not large enough to result in a purely sequential policy where the sector with high adjustment costs is liberalized first. The examples both illustrated the gradual liberalization would be undertaken in both sectors. This is probably due to the fact that the gains from liberalization are proportional to the level of the tariff, so the returns to making some immediate reductions from the Nash equilibrium in each sector are quite high.

IV. Conclusions

This analysis has illustrated how the existence of adjustment costs may give rise to an incentive to adopt trade liberalization agreements that are of a sequential nature when the policy choices are discrete. Adjustment costs have two effects in considering the benefits of liberalization. One is that the presence of a large number of workers in a sector makes liberalization more difficult to sustain because of the high cost of moving the workers. A second is that once the sector has been shrunk by past liberalization, it becomes more difficult to go back to the previous policy. These effects seem intuitively appealing, as they capture the idea that the liberalization process becomes much more secure once resources have been moved out of a sector. This locking in of resources from early stages of liberalization can be used to facilitate later types of integration. For the case of continuous policy choices, these lock in effects also play a role, although the results for the model considered indicate that countries are likely to gain from engaging in at least some liberalization in each sector at the early stages of the agreement. This suggests it would be useful to extend the model to allow for a richer set of spillovers between sectors.

It seems likely that the size of a sector would also play a role in its political impact on the trade liberalization process. Once a sector has been shrunk, it also has less political influence and the liberalization process is likely to be reversed. A useful extension of the model would be to allow the government to place greater weight on the returns to workers in the import-competing sector. This could be done by explicitly considering the case where workers must pay adjustment costs, so that wages would ball below the level in the numeraire sector as a result of liberalization.

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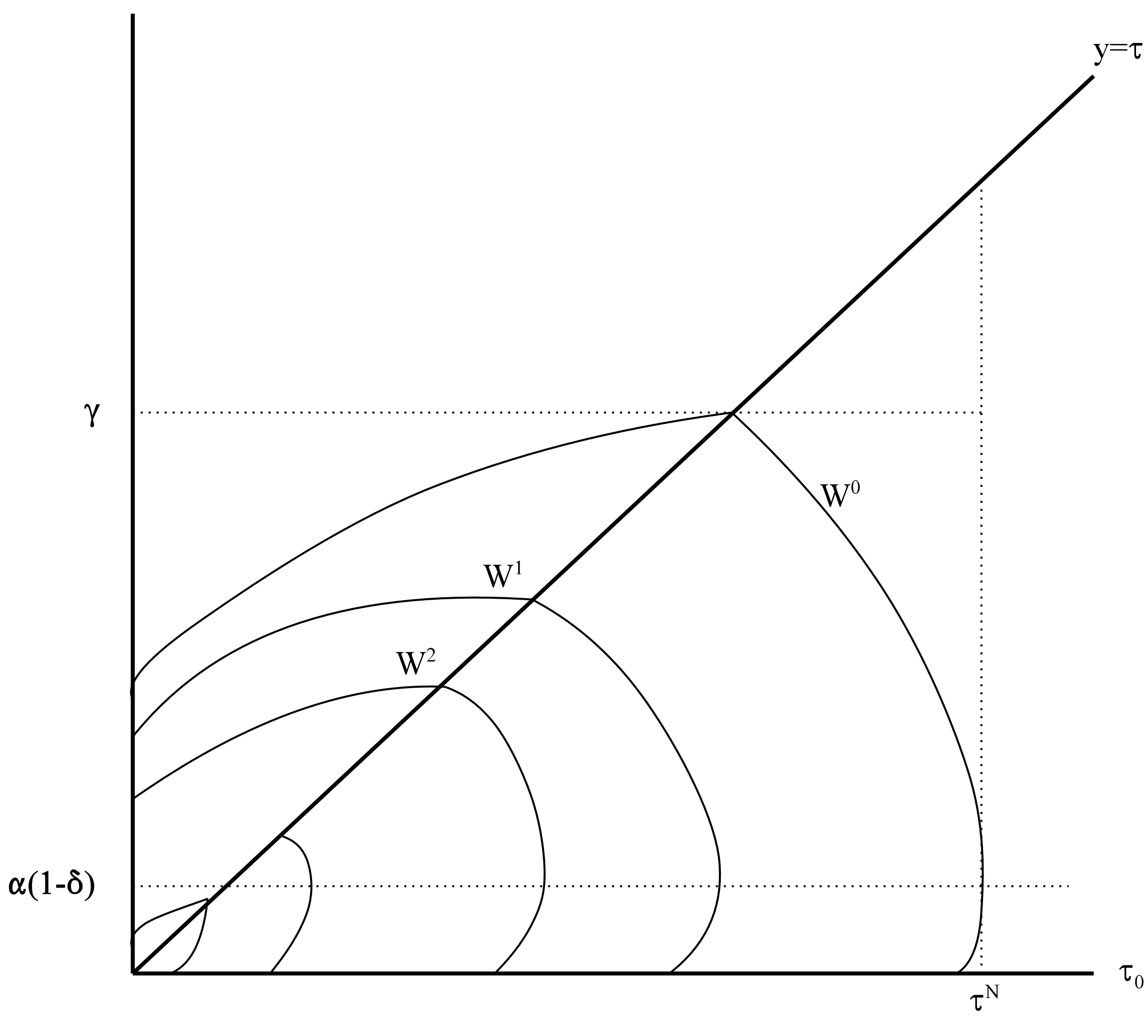
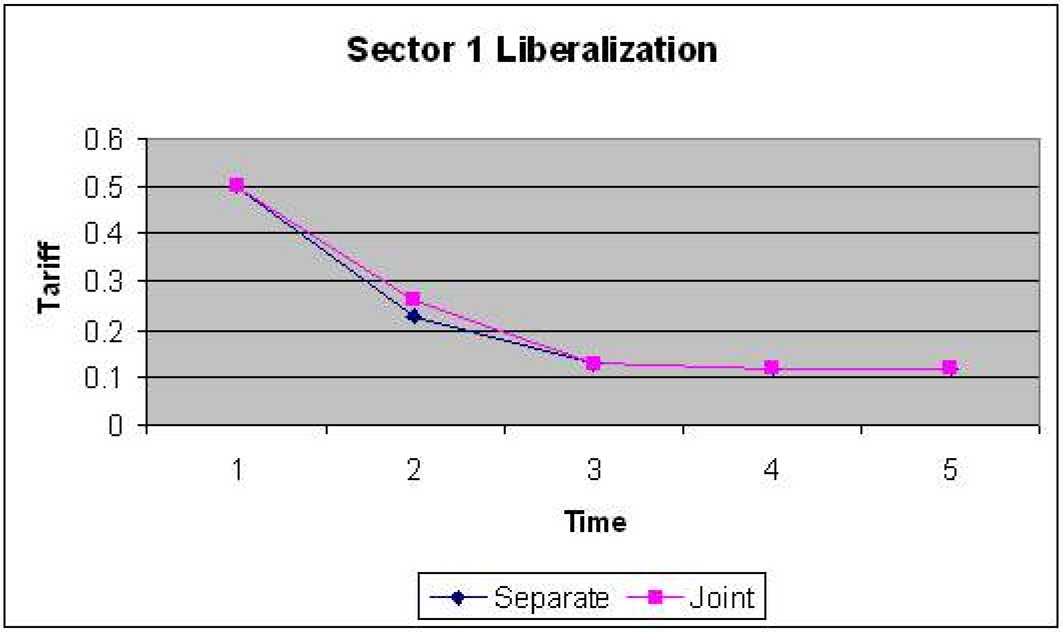
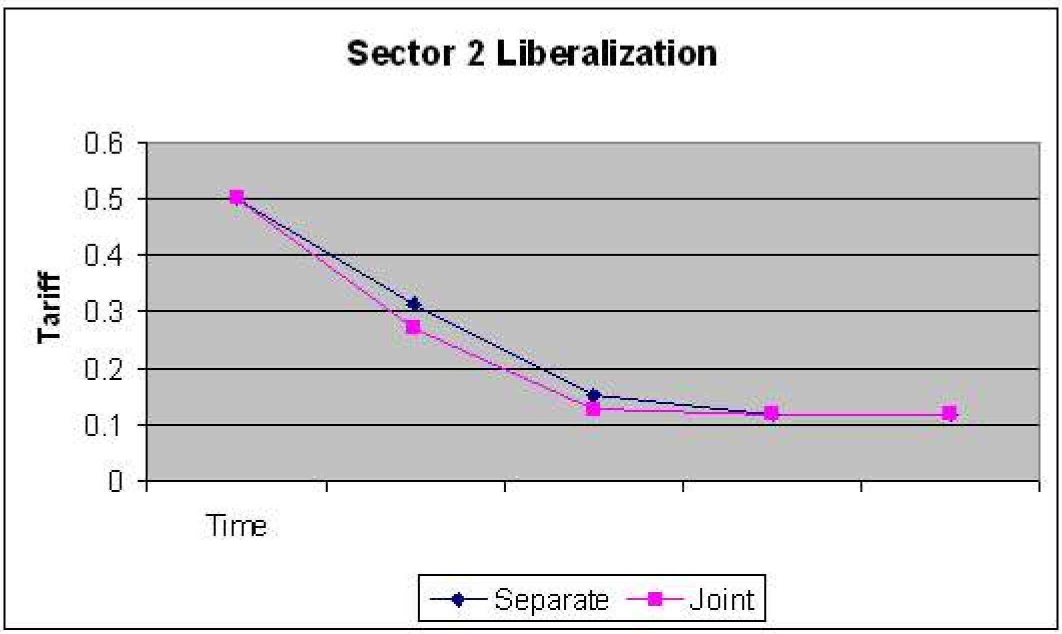


y=τ
γ
W0
W1
W2
α(1-δ)
τ0
τN

Case	Common Sectoral Paramters	Differing Sectoral Parameters	δ_1^C 1 only	δ_2^C 2 only	δ_{Sim}^C	δ_{Seq}^C 1 first	δ_{Seq}^C 2 first
1	a=11,b=1 e =5.5, β=.2	α_1 = .2 α_2 = .4	.718	.739	.728	.637	.610
2	a=11,b=1 e=5.5,α=.3	β_1 = 0 β_2 = .3	.708	.738	.723	.660	.594
3	b=1; e = 5.5 α= .2; β = 0	a_1 = 11 a_2 = 10.4	.695	.685	.687	.664	.646





Liberalization Paths for Case 2: Separate Liberalization by Sector vs. Joint Liberalization

$\delta = .6$

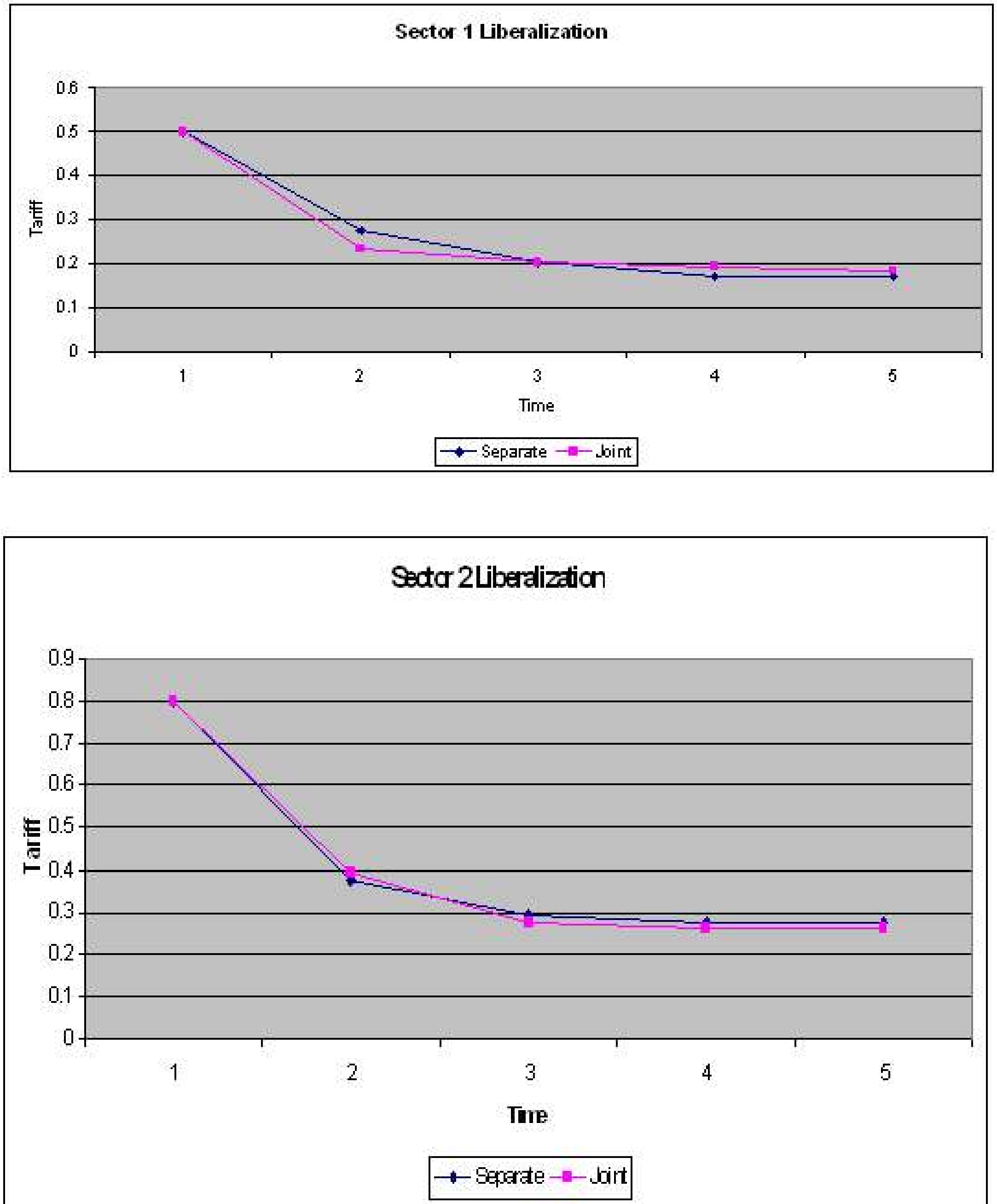


Figure 3: Liberalization Paths for Case 3, Separate Liberalization vs. Joint Liberalization

Appendix

Proof of Proposition 1: Let $H_i(y_i) = V_{Mi}(y_i) + V_{Xi}(y_i) - (1 - \delta) [\alpha_i(\tau_i^N - y_i)/b + \Psi(y_i, \tau_i^N)]$, which is the difference between the average payoff for a sequence of tariffs with $\tau_{i,0} = \tau_i^N$ and $\tau_{i,t} = y_i$ for $t \geq 1$ and the optimal deviation from that agreement at $t = 1$. Since the average payoff to the agreement is strictly concave in y_i and the deviation payoff is strictly convex in i for $y_i \in [0, \tau_i^N]$, H_i will be strictly concave in y_i on that interval. In addition, the function H_i has the properties: (i) $H_i(\tau_i^N) = 0$ and (ii) $H'(\tau_i^N) = (2\alpha_i (1 - \delta) + \beta(1 - \delta)^2 - \delta(2b_ie_i + 1 - a_i - \beta_i (1 - \delta) /(2b_i)$. It follows from these properties that if $H_i'(\tau_i^N) < 0$, there will exist a non-empty interval (γ_i, τ_i^N) such that $H_i(y_i) > 0$ for $y_i \in (\gamma_i, \tau_i^N)$. The condition in the proposition is the value of δ at which $H_i'(\tau_i^N) = 0$. This establishes that this agreement will be self-enforcing for sector i.

The joint agreement covering both sectors will be incentive compatible if $\sum_i H_i(y_i) \geq 0$, which will hold on the rectangle $[\gamma_1, \tau_1^N] \times [\gamma_2, \tau_2^N]$. This establishes that there exist stationary agreements that are incentive compatible at time 1, starting from $\tau_{i,0} = \tau_i^N$. In order for these agreements to be sustainable, they must also satisfy the no deviation constraint for $t > 1$, which requires $\sum_i [V_{Mi}(y_i) + V_{Xi}(y_i) - (1- \delta)\Psi(y_i, y_i)] > 0$. This follows immediately since $\sum_i [V_{Mi}(y_i) + V_{Xi}(y_i) - (1- \delta)\Psi(y_i, y_i)] > \sum_i H_i(y_i) \geq 0$ on this interval.