REVIEW OF INTERNATIONAL ECONOMICS
Manuscript No.: # 2016, Acceptance Date: March 13, 2003

Issue Linking in Trade Negotiations: Ricardo Revisited or No Pain No Gain*

Ignatius J. Horstmann
James R. Markusen
Jack Robles

RRH: Issue Linking in Trade Negotiations
LRH: Ignatius J. Horstmann, James R. Markusen and Jack Robles

Abstract

There has been much discussion about what issues should be included in international "trade" negotiations. Different countries, firms and activist groups have quite different views regarding which items should (or should not) be negotiated together. Proposals run the gamut from no linking to linking trade with investment, the environment, labor and human rights codes. This paper provides a formal framework for analyzing this question. It employs a two country, two issue bargaining model and contrasts outcomes when issues are negotiated separately and when they are linked in some form. A key concept is "comparative interest", analogous to Ricardian comparative advantage. We provide general results and note, in particular, where a country can benefit by agreeing to include an agenda item for which, when viewed by itself, the country does not receive a positive payoff. We also provide an application of our analysis to negotiations on trade liberalization and environmental protection.

* Horstmann: Rotman School of Management and Institute for Policy Analysis, University of Toronto, Toronto, ON M5S 3E6. Markusen and Robles: University of Colorado, Boulder, CO 80309. We thank seminar participants at the NBER Summer Institute, University of Colorado, Michigan State University and University of Toronto, as well as an anonoymous referee of this journal, for helpful comments and suggestions.

JEL Clasification Numbers: F13, F18, C78

Abbreviations: US, WTO, SPE, MPS/GE, GAMS, GE, NAFTA, EU
Number of Figures: 5 Number of Tables: 0
Date: March 31, 2003
Address of Contact Author: James R. Markusen, Department of Economics, University of Colorado, Boulder, CO 80309. Phone: 303-492-0748; Fax: 303-492-8960 ; e-mail: james.markusen@colorado.edu

1 Introduction

Considerable controversy exists over what issues should and should not be included in multilateral trade negotiations. Some US and European groups, for example, want environmental and labor standards included with trade negotiations. Other groups from these same countries want to link trade with investment liberalization and intellectual-property protection. Some developing countries want competition policy included with any negotiations on investment liberalization. Not surprisingly, a linked negotiation desired by one group is often opposed by some other group; some writers oppose any linkage (especially trade with environment/labor standards) "on principle". The latter see any European or US attempt to link trade and environment in negotiations with developing countries as morally wrong and simply assume that the developing countries must be worse off with such a linkage (an assumption generally shared by those developing countries).

How is one to assess the various arguments for and against linking? Two possible approaches suggest themselves as useful ways to analyze this issue formally. One is to investigate how treaties linking trade policies with other non-trade policy issues might (or might not) constrain non-cooperative policy-setting behavior more than would trade treaties alone. Much of the existing work on linked treaties takes this approach. The conclusions are decidedly mixed. Spagnolo (2000) argues that linking provides for more efficient enforcement of agreements by permitting more severe punishments for breaking the agreement. By contrast, Bagwell and Staiger (2001) argue that linking negotiations on trade with ones on domestic standards provides no benefits that can't be obtained without linking. Conconi and Perroni (2002) show that linking may help or hinder creation of a multilateral joint agreement on trade and the environment.

The alternative is to investigate how linking or not linking affects the actual treaty negotiation process and so the sorts of agreements that are (or are not) reached. Here, there are no formal analyses of the issues although Copeland and Taylor (1995) and Abrego et al. (2001) suggest potential benefits from linking trade and environmental treaties. This alternative approach is the one we adopt in this paper, providing a bargaining-theoretic framework for understanding who gains and loses by linking issues.[1] The framework that we employ is purposely simple, considering a situation in which there are two countries/trading blocs negotiating over two issues. The key distinguishing feature of the two issues is that one of them is more important to country 1 than to country 2 while the opposite is true for the other issue. This feature generates a pattern of "comparative interest" for the two countries in the two issues. This notion is analogous to Ricardian comparative advantage; it is somewhat more complicated in that negative payoffs from a given issue are an important part of the problem. With multiple issues, negotiations can involve either joint negotiations over both issues,linked negotiations, or some form of separate negotiations on the issues, unlinked negotiations. We solve for the bargaining outcome in the linked setting versus various unlinked settings and examine which party gains (and which, if either, loses) from a given structure and on what this outcome depends.

Our analysis shows that a change in the bargaining structure from one in which issues are negotiated in isolation to one in which they are negotiated jointly generates gains for both countries under a wide range of circumstances. These include situations in which one country cannot receive a positive payoff from one issue. This result means that a country should not necessarily refuse to add an issue to the agenda just because it cannot receive any positive payoff from that issue when viewed in isolation. Adding this issue may allow the country to extract sufficient concessions from its negotiating partner on the other issue as to make the country better off overall. It is only if an issue yields the country an exceptionally large negative payoff, when viewed in isolation, that it pays the country not to link issues.

The reason that both parties gain, in general, from linking in this situation is much the same as the reason that trade benefits both countries in a Ricardian trade model. Just as trade allows each country to exchange the good in which it has a comparative advantage for the good in which it does not, linking allows each country to trade concessions on the issue in which the country has a comparative disinterest for concessions from its opponent on the issue in which it has a comparative interest. This efficient trading of concessions is not possible if the issues are bargained independently. As a result, just as with Ricardian trade, both parties gain from this efficient trading process (via linking). Not linking only benefits a country if an issue yields a sufficiently large negative payoff. In this case, not linking provides the country with a credible commitment not to settle on this issue. This commitment is lost under linking.

We also examine an alternative notion of unlinked negotiations in which the countries bargain issues sequentially, not bargaining on the second issue until an agreement on the first has been reached and implemented. Under this notion of unlinking, an unlinked negotiation in which the issue that is bargained first is the one in which a country has a comparative interest can be preferred by that country to a linked negotiation. In this case, unlinking alters the relative bargaining costs of the two countries in a such a way that the one country gains even relative to the linked bargain. By contrast, the other country loses even in comparison to the completely separate negotiations. Among other things, this outcome points to the fact that, in discussing linking versus not linking, one must be careful to consider what exactly is meant by not linking.

Finally, to illustrate how our analysis can be applied in trade settings, we present a model of trade and the environment reminiscent of the models of Copeland and Taylor and Markusen (1975a; 1975b). The model is a numerical general equilibrium trade model with a large, rich country and a small, poor country. The rich country has monopoly power in trade and a (relatively) high valuation for environmental quality. This feature gives the rich country a comparative interest in environmental quality and a comparative disinterest in trade liberalization. For the poor country, it is the opposite. The countries negotiate tariff reductions and pollution tax increases from an initial point of Nash equilibrium tariffs/taxes. Using the results from our bargaining analysis, we show that unlinked negotiations lead to no trade liberalization nor additional pollution abatement. Linked negotiations, on the other hand, produce liberalization to free trade and increased pollution abatement.

Our results carry a clear policy message. If the alternative to linked negotiations is simultaneous but separate negotiations, then countries can generally benefit from linking. In this case, it may well not pay a country to refuse to include an issue in negotiations simply because the country cannot receive a positive payoff from that issue (viewed in isolation). Inclusion of the issue allows for efficient trading of concessions that can benefit all parties. If the alternative to linking is sequentially separate negotiations – reach an agreement on trade first and only later negotiate agricultural subsidies or the environment – then not linking may well benefit a country if it can negotiate first on the issue in which it has a comparative interest. The country's negotiating partner should press for linked negotiations in this case.

2 A Stylized Model of Negotiations

Consider a situation in which there are two surpluses, S_1 and S_2, to be allocated between two individuals, 1 and 2. The value of S_2 is normalized to 1 while the value of S_1 is assumed equal to s with $s > 0$. The instantaneous utility functions for agents 1 and 2 are given by

$$U_1 = b_1 sx + (1 - c_2 - y) \quad (1)$$

$$U_2 = (s - c_1 - sx) + b_2 y, \quad (2)$$

respectively, with $x \in [0,1]$ giving agent 1's share of S_1 and $y \in [0,1]$ giving agent 2's share of S_2.[2] The preference parameters b_1, b_2 give, respectively, agent 1 and 2's valuations of S_1 relative to S_2. It is assumed that $b_1, b_2 > 1$, implying that agent 1's marginal utility from S_1 is greater than from S_2 (1 prefers S_1 to S_2) while the opposite is true for agent 2 (2 prefers S_2 to S_1). The parameters $c_1, c_2 \geq 0$ represent costs of creating S_1 and S_2. It is assumed that agent i bears the cost of creating the surplus that i likes less (agent 1 bears the cost of creating S_2 and agent 2 the cost of creating S_1). The reason for this specification is twofold. First, it guarantees that, both on preference grounds and cost grounds, agent 1(2) prefers S_1 to S_2 (S_2 to S_1). Second, it allows for the possibility that agent 1, for instance, might obtain negative utility from the creation of a positive utility for agent 2. This outcome occurs if agent 2 gets more than the amount $1 - c_2$ of S_2.

This specification is meant to capture several features of trade negotiations. First, in any negotiation, certain policies are more important to certain countries and less important to others. In the Canada/US trade negotiations, for instance, Canada attached greater value to free trade than did the US; the US, on the other hand, attached far greater value to reform of foreign investment rules than did Canada. Second, it's possible that a country can make a sufficient concession on same trade policy that, in the absence of any other changes, the country is worse off. Such is presumably the case for developing countries conceding to strong intellectual property protections under the WTO. The above specification captures both of these features and allows us to analyze the ways in which trade negotiations are affected by them.

Both objects are allocated via a bargaining process. Bargaining is modelled as a non-cooperative, alternating offers game *a la* Rubinstein (1982). Both agents know the values of S_1 and S_2 as well as the utility functions. Bargaining costs are modelled as delay costs, with each agent discounting the future at a common, known rate δ. The equilibrium notion is subgame perfect Nash.

Because there are two surpluses to be divided, a complete specification of the game requires a specification of the bargaining agenda (the order in which issues are bargained) and a rule for implementing agreements. The agenda and implementation rule determine the sense in which issues are linked (or not linked). Initially, we consider linked an unlinked structures in their starkest forms. Specifically, the linked structure requires agents to bargain over the two surpluses together in the sense that an offer under the linked structure is a pair $[x, y]$ defining an allocation of both surpluses. All offers must be of this form and an offer must either be accepted in its entirety or rejected completely. An offer is implemented (allocations are made) as soon as it is accepted. Until an agreement is reached (or if no agreement is ever reached), the *status quo* point remains in effect with the utility for each agent normalized to zero in this case.

Under the unlinked structure the agents operate two bargaining games, one for the division of S_1 (game G_1) and one for the division of S_2 (game G_2). These games are entirely separate in the sense that they operate simultaneously and there is no possibility of trade-offs across games. Formally, under the unlinked structure, an offer in G_1 is a value x and an offer in G_2 is a value y. An offer in G_1 cannot be conditioned on the history in G_2 and *vice versa*; the same is true for an accept/reject decision. An agreement in either game is implemented as soon as it is reached in that game and independent of events in the other game. As with the linked structure, until an agreement is reached in a game (or if no agreement is ever reached) the *status quo* point remains in effect with the utility for each agent normalized to zero.

The sense in which these two structures represent the extreme forms of linked and unlinked bargaining structures is as follows. The linked structure permits the agents to fully exploit the benefits from trading-off concessions on their less preferred surplus for concessions by their opponent on the more preferred surplus. The trading of concessions cannot be limited by the agents making offers on only one of the objects or by accepting and implementing only part of an offer. The unlinked structure, by contrast, allows no trading of concessions (nor any exploitation of the benefits from so doing) as each surplus is bargained over separately and implemented separately.

In a subsequent section, we explore alternative notions of linking and unlinking issues involving bargaining structures that incorporate partial restrictions on the agents' abilities to trade concessions. These agendas allow linked bargaining but with partial offers (offers on only one of the two surpluses) that can be implemented immediately should they be accepted. We also discuss ways to interpret these different structures in terms of actual trade negotiations.

3 Linked Versus Unlinked Negotiations

Consider, first, unlinked negotiations.[3] The unlinked bargaining structure is equivalent to two separate Rubinstein bargaining games (G_1 and G_2) with agent preferences in G_1 given by $U_1^1 = b_1 sx$ and $U_2^1 = s - c_1 - sx$ and those in G_2 given by $U_1^2 = 1 - c_2 - y$ and $U_2^2 = b_2 y$. It is well known that each of these games has a unique subgame perfect equilibrium (SPE) and that, as $\delta \to 1$, the equilibrium utilities converge to the Nash bargaining solution over the utility frontier for the given game. To facilitate comparisons between utilities under the linked and unlinked structures, we study only these limiting equilibria and the corresponding utilities implied by the appropriate Nash bargaining solution.

For the bargaining game G_1, the Nash bargaining solution is defined by the maximum of 0 and the utilities given by the problem

$$\begin{aligned} & \max_{u_1^1, u_2^1} U_1^1 U_2^1 \\ s.t. \quad U_1^1 &= sb_1 - b_1(U_2^1 + c_1) \end{aligned} \tag{3}$$

Similarly, for G_2, the Nash bargaining solution is the maximum of 0 and

$$\begin{aligned} & \max_{u_1^2, u_2^2} U_1^2 U_2^2 \\ s.t. \quad U_2^2 &= b_2 - b_2(U_1^2 + c_2). \end{aligned} \tag{4}$$

The frontiers for these problems are represented in Figure 1 for the cases $c_1 = c_2 = 0$ and $c_1 > s, c_2 > 1$

In the bargain over S_1, the limiting SPE yields utility for agent 1 given by $U_1^1 =$

$\max[0, .5b_1(s - c_1)]$ and utility for agent 2 of $U_2^1 = \max[0, .5(s - c_1)]$. In the bargain over S_2, the limiting allocation yields utilities of $U_1^2 = \max[0, .5(1 - c_2)]$ and $U_2^2 = \max[0, .5b_2(1 - c_2)]$. If $c_1 \leq s$ and $c_2 \leq 1$, then total utility for agent 1 under the unlinked agenda is then $U_1^1 + U_1^2 \equiv U_1^u = .5(sb_1 - b_1c_1 + 1 - c_2)$ and for agent 2 it is $U_2^1 + U_2^2 \equiv U_2^u = .5(b_2 - b_2c_2 + s - c_1)$. Utility for the other cost configurations can be derived similarly.

Under the linked bargaining structure it can be shown that the bargaining game is equivalent to one in which each player's offer is a utility pair drawn from the utility possibility frontier, $\mathcal{U}_L$. This frontier is defined by

$$\begin{aligned} \max_{x,y} U_1 &= b_1sx + 1 - c_2 - y \\ s.t. \quad U_2 &= s - c_1 - sx + b_2y = \overline{U}, \end{aligned}$$

and is illustrated in Figure 2 for the case $c_1, c_2 = 0$. The linked bargaining game has a unique SPE whose limiting value as $\delta \rightarrow 1$ is the Nash bargaining solution over $\mathcal{U}_L$.

Because the utility frontier for S_1 is everywhere steeper than that for S_2, a point on $\mathcal{U}_L$ must have at least one agent obtaining all of the surplus preferred by that agent (i.e., either agent 1 must at least have all of S_1 or agent 2 at least have all of S_2). When both surpluses are allocated under the unlinked structure (which occurs if $s > c_1$ and $1 > c_2$), neither agent obtains all of either surplus. As a result, the utility point under the unlinked structure must be strictly inside $\mathcal{U}_L$. In this case the linked bargain must make at least one of the agents better off. The only question is whether both are made better off. The following proposition provides conditions under which both agents are strictly better off from linking. The proof of the proposition is in the Appendix.[4] See Figure 3 for an illustration of the result.

Proposition 1 *If $s > c_1 > 0$ and $1 > c_2 > 0$, then the linked bargain yields strictly higher utility for both agents relative to the unlinked bargain.*

Several points about this result are worth noting. First, it's important for the result that $b_1, b_2 \neq 1$; that is, it's important that the agents have comparative interests in different surpluses. Were $b_1, b_2 = 1$, then the unlinked bargain would also give a point on the $\mathcal{U}_L$. Specifically, it would give the point $U_1 = U_2 = .5(1 + s - c_2 - c_1)$. Since the slope of the utility frontier is 1 in this case, the linked and unlinked bargains give the same outcome. That $b_1, b_2 \neq 1$ (there are differing interests) means that the unlinked bargain puts the agents strictly interior to the utility space of the linked bargain. In this case, linking produces utility gains for both agents by allowing an efficient allocation of the goods (as long as the transfer costs are not too large).

In a similar vein, it is important that $c_1, c_2 \neq 0$. Positive costs mean that the unlinked bargain produces an additional misallocation due to agent i having to give j some of the surplus that i prefers simply to induce j to participate at all in the unlinked bargain. More concretely, consider the bargain over S_2 in the unlinked case. In this bargain, agent 1 has zero cost of making a counteroffer unless he obtains at least c_2 units of S_2. This fact gives 1 extra bargaining power (relative to the case in which $c_1 = 0$) and so 1 extracts more S_2 (the good that 2 prefers). The linked agenda allows 2 to compensate 1 for the cost c_2 through S_1 (and similarly allows 1 to compensate 2 for c_1 through S_2) and so provides an additional efficiency gain.

It is less important that net surplus is always positive ($s > c_1$ and $1 > c_2$). Linking can still benefit both agents even when $s \leq c_1$ and $1 \leq c_2$. The application in Section 5 provides an example. Only if the cost of creating a given surplus is sufficiently large will the unlinked structure be preferred by one of the agents to linking. To see the reason, consider the situation in which that $c_2 > 1$ while $c_1 < s$. In this case the unlinked structure results in S_2 not being allocated, with a cost saving to agent 1 of c_2. With the linked structure, agent 1 gives up the ability to refuse to allocate S_2. While agent 1 can be compensated for c_2 through a larger share of S_1 in the linked structure (the benefit of the linked structure over the unlinked one), c_2 may be sufficiently large that agent 1 is still made worse off by linking. The following proposition defines conditions under which agent 1 loses from linking.[5]

Proposition 2 *Suppose that* $c_2 > 1$ *and* $0 < c_1 < s < 2c_2/b_1 - c_1$. *If, in addition,* $c_1(b_1 - 1/b_2) < c_2 - 1 < .5(s + c_1)(b_1 - 1/b_2)$, *then agent 1 prefers the unlinked structure to the linked while agent 2 prefers the linked structure to the unlinked.*

The situation described in the proposition is depicted in Figure 4. Note in the figure that the utility frontier for the linked structure intersects the U_1-axis below the intersection point of the utility frontier for the unlinked structure. This outcome is the implication of the condition $c_1(b_1 - 1/b_2) < c_2 - 1$ and means that, as measured by the maximum payoff attainable by agent 1, linking is detrimental to 1. Note also that the utility pair under the unlinked structure lies inside the utility frontier of the linked structure. Under the assumption that s is small relative to c_2 ($s < 2c_2/b_1 - c_1$), this utility outcome is implied by the condition $c_2 - 1 < .5(s + c_1)(b_1 - 1/b_2)$ and means that at least one of the agents must gain from linking. Combined, these three conditions mean that the bargaining solution for the linked structure yields agent 1 less utility and agent 2 more utility than under the unlinked structure.[6]

To sum up, as long as it is feasible for bargaining to generates gains, relative to the *status quo*, for both agents on both surpluses, then both agents benefit from having a linked structure. For cases in which neither agent can possibly gain from the bargain over the issue in which that agent has a comparative disinterest, the linked structure may still benefit both agents. It is only when the potential loss to an agent on a given issue is sufficiently large that the agent benefits from the unlinked structure. In this case, unlinking allows the agent to credibly commit to not moving from the *status quo*. It does so by allowing the agent to delay indefinitely agreement on the issue. By linking, the agent gives up this commitment since delaying agreement indefinitely delays agreement on both issues. As a result, in spite of the efficiency gains from linking, the agent can be worse off with a linked structure. This outcome occurs when the issue in which the agent has a comparative interest is small relative to the cost associated with the issue in which he has a comparative disinterest.

4 An Alternative Unlinked Structure

The two bargaining structures above place linked and unlinked bargaining in particularly stark contrast. Unlinked bargaining allows no efficient trade-off of surpluses while linked bargaining permits full exploitation of such trade-offs. Other bargaining structures are possible, even in this simple setting, that permit alternative characterizations of linked/unlinked bargaining. We examine these structures here and provide a comparison with the above results on the gains from linking.[7]

The additional bargaining structures available in this setting are ones in which issues can be bargained sequentially and implementation of an agreement on one issue is linked in various ways to whether or not agreement has been reached on the other issue. Essentially, three additional structures are available: 1) The agents bargain only on S_1 and once agreement has been reached on S_1 bargain on S_2. The agreement on S_1 is binding (in the sense that it can't later be re-opened) and is implemented at a fixed date whether or not agreement is ever reached on S_2. 2) The agents bargain only on S_2 and once agreement has been reached on S_2 bargain on S_1. The agreement on S_2 is binding and is implemented at a fixed date whether or not agreement is ever reached on S_1. 3) The agents bargain only on S_1 (S_2) and once agreement is reached on that surplus bargain on S_2 (S_1). The agreement on S_1 (S_2) is binding but is only implemented once agreement has been reached on S_2 (S_1). Fershtman (1990) has shown that, unless the two surpluses are of very different sizes, procedure 3 generates the same outcome as the linked bargain as $\delta \to 1$. In this case, then, there are basically two other structures (1 and 2 above), each with a sequential (implement as agreement is reached) implementation rule.

These two structures, which we refer to as sequentially unlinked structures, provide an alternative notion of unlinked bargaining. In these cases, the bargaining is unlinked in two senses. First, implementation of an agreement on the first surplus is independent of whether or not agreement is ever reached on the second. This is as in the unlinked structure above and in contrast to the linked structure. Second, because of this implementation rule, bargaining on the second surplus is unaffected by any agreement on the first. Again, this is as in the unlinked structure above.

This structure is different from the unlinked structure because bargaining on the second surplus only commences once agreement has been reached on the first. As a result, the bargained outcome on the first surplus depends on the agreement that will be reached on the second surplus. This fact means that there is some scope for efficient trade-offs under this structure not available under the above unlinked structure. As a result, these sequentially unlinked structures yield different outcomes from the previous unlinked structure.

Under this sequential notion, unlinked trade negotiations are ones that delay negotiation on certain issues until agreements on others have been reached. For instance, negotiations on agricultural subsidies are delayed until agreement has already been reached on intellectual property issues. Alternatively, negotiations on environmental issues are delayed until agreement had been reached on free trade. What are the benefits of structuring negotiations in this way?

To answer this question we need to determine the bargained outcome under the sequential structure and compare utilities to those under the linked an unlinked structures? To get some sense of the comparisons consider, first, the case in which $c_1 = c_2 = 0$ and consider the structure S_1 then S_2. Once agreement is reached on S_1, the bargain on S_2 has no impact on the utility that agents receive from the S_1 agreement: the agreement is binding and the allocation of S_1 is made upon agreement. As a result, the bargain on S_2 is as under the unlinked structure, with the limiting allocation being $y = .5$ and the limiting utilities from S_2 being $U_1 = .5, U_2 = .5b_2$.

The bargain on S_1 is different from the unlinked structure due to the sequential nature of the bargaining here: bargaining doesn't begin on S_2 until agreement is reached on S_1. The sequential structure means that failure to reach agreement on S_1 delays agreement on (and consumption of) S_2. As a result, both agents bear a utility cost from continued bargaining on S_1 that reflects their valuations of both S_1 and S_2. Under the unlinked structure, by contrast, the utility cost of continued bargaining on S_1 reflects only the agents' valuations of S_1. It is shown in the Appendix that, as long as $b_2 > s + \frac{1}{b_1}$, the relative bargaining costs under the sequentially unlinked structure are such that agent 1 obtains all of S_1. In this case, the sequentially unlinked structure yields agents a utility point on the frontier of the utility possibility set, $\mathcal{U}_L$, given by $U_1^{s1} = sb_1 + .5, U_2^{s1} = .5b_2$.

How does this outcome compare to that of the linked and unlinked structures? For this case, the linked structure outcome has agent 1 getting all of S_1 and agent 2 all of S_2, yielding utilities $U_1^l = sb_1, U_2^l = b_2$. The unlinked structure gives utilities $U_1^u = .5sb_1 + .5, U_2^u = .5b_2 + .5s$. Clearly, agent 1 prefers the sequentially unlinked structure to the linked structure ($U_1^{s1} > U_1^l > U_1^u$) while agent 2 finds the sequentially unlinked structure worst of all ($U_2^{s1} < U_2^u < U_2^l$).

A similar analysis can be performed for the structure S_2 then S_1. As long as

$b_1 > \frac{1}{s} + \frac{1}{b_2}$, the outcome again will be on the utility frontier with agent 2 getting all of S_2 and half of S_1. The utilities for the two agents for this structure are $U_1^{s2} = .5sb_1, U_2^{s2} = b_2 + .5s$. In this case, agent 2 prefers this sequentially unlinked structure to all others while agent 1 finds this structure worse than even the unlinked structure. So we have:

Proposition 3 *Suppose that i) $c_1 = c_2 = 0$ and ii) $b_1 > \frac{1}{s} + \frac{1}{b_2}, b_2 > s + \frac{1}{b_1}$, then agent 1(2) prefers the sequentially unlinked structure S_1 then S_2 (S_2 then S_1) to all other bargaining structures. Agent 2(1) finds the sequentially unlinked structure S_1 then S_2 (S_2 then S_1) worse than the unlinked structure.*

The intuition for this result can be found in the way that the various structures affect the agents' relative bargaining costs. Under the linked structure, agent 1 finds it costly to hold out for a positive share of S_2 since doing so delays agreement on (and consumption of) S_1, the surplus 1 prefers. Similarly, 2 finds it costly to hold out for a positive share of S_1 since doing so delays agreement on (and consumption of) S_2, the surplus 2 prefers. The result is that each agent obtains all of the surplus that that agent prefers and none of the other surplus.

In the sequentially unlinked structure S_1 then S_2, 1 has already obtained his allocation of S_1 before bargaining on S_2 begins. As a result, it is now cheap for 1 to hold out for a share of S_2 since doing so doesn't delay consumption of S_1. In essence, 1's bargaining costs on S_2 are now low relative to 2's and so 1 obtains a positive share of S_2. In the prior bargain over S_1, the agents' relative bargaining costs are not much changed from the linked bargain: it's relatively costly for 1 to concede some of S_1 since this surplus is the one that 1 prefers and 2's holding out for a large share of S_1 continues to delay agreement on S_2. Overall, then, the sequentially unlinked structure S_1 then S_2 lowers 1's bargaining costs relative to 2's and so puts one in a favorable bargaining position relative to the linked structure. Two is damaged both relative to the linked structure and the unlinked structure since 2 continues to concede on S_1 because not doing so delays agreement on S_2 (which is not so in the unlinked structure). Analogous arguments explain 2's preference (and 1's dislike) for the structure S_2 then S_1.

When $c_1, c_2 > 0$, the sequentially unlinked structure inherits some of the same inefficiency properties that the unlinked structure has. Specifically, an agent is compensated for the cost of creating a given surplus directly from that surplus rather than indirectly from the surplus that the agent prefers more. If costs are large enough, this inefficiency can result in an agent preferring the linked structure to that agent's favored sequentially unlinked structure.[8]

Positive costs do not reverse agent preferences regarding the unlinked and sequentially unlinked structures, however (see the Appendix for a proof). Specifically, agent 1 always (weakly) prefers the sequentially unlinked structure S_1 then S_2 to the unlinked structure while agent 2's preferences are the opposite. Similarly, agent 2 prefers the sequentially unlinked structure S_2 then S_1 to the unlinked structure while agent 1's preferences are the opposite. The reasons are as above. In particular, both sorts of unlinked structures suffer from the same inefficiencies that arise when costs are positive but the sequentially unlinked structure alters relative bargaining costs in a way that is favorable to one agent and unfavorable to the other.

Proposition 4 *If $s \geq c_1 > 0, 1 \geq c_2 > 0$, then agent 1(2) (weakly) prefers the sequentially unlinked structure S_1 then S_2 (S_2 then S_1) to the unlinked structure. Agent 2(1) finds the sequentially unlinked structure S_1 then S_2 (S_2 then S_1) (weakly) worse than the unlinked structure.*

5 Application: Negotiating Trade Liberalization and Environmental Protection

The results in the preceding section were derived from a highly stylized bargaining model. To demonstrate the relevance of our analysis to actual trade settings, we provide in this section an application of our methodology to negotiations on trade liberalization and environmental policy. The analysis of the negotiation problem is framed within a numerical general-equilibrium model motivated by the trade and environment model of Copeland and Taylor and the earlier work of Markusen. The model captures the essence of these papers and has the crucial feature of our theory: there is a pattern of comparative interest in the two issues at stake which permits gains from linking.

The model is, in most respects, a standard two-good, two-factor, two-country Heckscher-Ohlin model. It differs from Copeland and Taylor in one significant way: goods are not distinguished as clean or dirty and so countries have no comparative advantage in a clean or dirty good. This assumption serves to separate the environmental problem from the protection issue and so keep the model closer in spirit to the analysis of the preceding section. The specifics of the model are listed below:

1. There are two countries, h and f. Country h is four times the size of country f as measured by income in a free-trade equilibrium.

2. Country h exports X, the capital intensive good and country f exports Y, the labor intensive good.

3. Preferences in the two countries are Cobb-Douglas and defined over X, Y and environmental quality. The latter is exogenous to the individual consumer. Preferences over X and Y are identical across countries so that, at identical (free trade) prices, consumers purchase X and Y in the same proportion in the two countries.

4. Environmental quality is a pure pubic good across and within countries. In alternative terminology, pollution is perfectly trans-border.

5. Consumers in the two countries attach different relative values to private consumption and environmental quality. Consumers in the big/rich country (h) have a value share on environment that is five times that in the small/poor country (f). Although preferences are homogeneous, we could think of this assumption as approximating a situation in which the country-size difference is purely in per-capita income and environmental quality has a high income-elasticity of demand.

6. The level of environmental quality or pollution does not vary directly with the composition of production: the amount of pollution produced at any point on a country's production possibility frontier is the same. This assumption neutralizes any issues concerning whether a country has a comparative advantage in clean or dirty goods.

7. There is a production activity, called abatement, which uses goods X and Y in the same Cobb-Douglas proportions as those used to generate utility. In other words, the subutility "good" produced from X and Y is the sole input into abatement. As in the case of item 6, this assumption removes any "comparative advantage" in the abatement activity.

8. Each country has two tax instruments: i) They can impose an import tariff where the revenue is lump-sum redistributed to the representative consumer and ii) they can impose a uniform consumption tax on X and Y to generate revenue to pay for the abatement activity.

Note that, as a consequence of item 6, Pareto optimality in the world economy involves free trade: departures from free trade only reduce the value of private consumption without affecting environmental quality. Item 7, combined with the assumptions that the abatement production function is the same in the two countries and that pollution is a pure international public good, implies that Pareto optimality in the world economy should involve equal consumption taxes so that the marginal cost of abatement is the same in the two countries.

To analyze the negotiated outcome in the above model under the linked versus unlinked structures, we first need to define a *status quo* point. We assume that this point is given by the Nash equilibrium tariffs and abatement taxes for the two countries. To find these values, the above model is coded in Rutherford's MPS/GE language into GAMS. The model is calibrated to initial values for free trade and no abatement taxes and a replication check is run to see that the model reproduces the benchmark values. The calibrated model is then run over a grid of tariff values for the two countries to find the Nash equilibrium tariff rates. These tariffs are 140% for the large country (h) and 10% for the small country (f). This qualitative difference is anticipated from theory due to the differences in country size, although theory cannot predict the size of the difference.

We also do a grid search over environmental taxes using the above tariff values to find Nash equilibrium abatement taxes. These are 20% for country h and 0% for country f, reflecting their different valuations of environmental quality. Any tax imposed by country f primarily benefits country h and so f's optimal (Nash equilibrium) tax is zero. Finally, we rerun the model with these abatement taxes to see if the tariff rates are still Nash rates and indeed they are (at least for the grid steps used, 5% for country h and 2% for country f). Thus we have a full Nash equilibrium in two policy instruments where country h has a tariff of 140% and an abatement tax of 20%, and country f has a tariff of 10% and an abatement tax of 0%. These taxes define the *status quo* taxes; we re-normalize utility at this point to 0 for each country. Figure 5 gives the *status quo* at the origin, with the welfare of country f on the vertical axis and that of country h on the horizontal axis.

To analyze the outcome of trade negotiations for this model, one needs to take a stand on two issues: i) the feasible proposals for tariff reductions and abatement tax increases and ii) the assumed values of abatement taxes (tariffs) in the negotiation over tariffs (abatement taxes) in the unlinked structure. For tariffs, we assume that countries consider equal proportional reductions in their tariffs until free trade is reached. In the unlinked structure, this is done assuming that abatement taxes are fixed at their Nash levels. Repeatedly solving the model in steps of equal proportional reductions until free trade is reached, we obtain the payoff frontier for the tariff negotiations under the unlinked structure. This frontier is depicted in Figure 5 at the left of the diagram. Country h is worse off in free trade than in the Nash equilibrium, an outcome predicted for a large country by Johnson (1954), and consistent with US-Canada results found in Markusen and Wigle (1990).

It is a little more arbitrary how to think about bargaining in the pollution abatement game. Experiments with the model indicate that increasing equal tax rates beyond 30% makes both countries worse off (private consumption losses exceed improved environmental quality). We then start at the Nash equilibrium and increase the taxes in steps until both countries are at 30% (so in 10 steps, each step is 1% for country h and 3% for country f). Doing so generates the payoff frontier for the abatement negotiations under the unlinked structure. This frontier is given by the lower frontier in Figure 5. Because of its low valuation for quality and small size (most benefits going to country h), country f is always worse off and its losses increase monotonically with the tax rates.

Our trade model generates features at the heart of this paper: each country has a comparative interest in one issue and each can only lose from any agreement on its other issue. For this case, the analysis in the previous section reveals that the unlinked structure produces no movement from the *status quo* point: there is no trade liberalization nor any movement on environmental protection.[9] The same is true under a sequentially unlinked structure. For this case, trade liberalization requires linking the negotiations to pollution abatement.

If we ignore general equilibrium interdependencies for a moment, we can construct a utility frontier for the case in which tariffs and abatement taxes are negotiated together. This frontier is shown in Figure 5, where the "kink" is free trade and both countries imposing abatement taxes of 30%. This frontier is an approximation to the actual frontier under the linked structure and reveals that, by linking trade liberalization to pollution restrictions, both countries can be better off. The frontier that includes general equilibrium effects, and so is the actual frontier for the linked structure, lies outside this frontier and is labelled "GE outcomes" in Figure 5. Again, this frontier indicates that both countries are made better off by a linked structure.

6 Summary and Conclusions

In this paper we have explored the potential benefits (and costs) of linking agreements on trade with agreements on other, non-trade issues. Our analysis suggests that linking may well be a virtue rather than a vice. By linking, a country can extract concessions from its negotiating partners on an issue of importance to that country in exchange for concessions on issues of importance to its partners. This efficient trading of concessions can be beneficial to a country even in circumstances in which the linked issue, when viewed in isolation, has negative marginal value to the country.

The US-Canada free trade negotiations and later the NAFTA negotiations may provide an example of just this point. The US wanted to provide tough provisions on services and investment while Canada preferred to stick with goods only. If Canada and Mexico had not agreed to include services and investment, our guess is that the negotiations would have failed since there was little support (rightly or wrongly) in the US for trade in goods, especially with Mexico. By agreeing to include issues in which Mexico and Canada perceived (rightly or wrongly) that they had nothing to gain, these two countries improved their welfare through trade concessions that were worth more than what they gave up on services and investment.

When linking is not beneficial to a country it is either because the linked issue has very large (relative to other issues) negative value or because the country can gain by bargaining issues sequentially. In this latter case, sequential bargaining beginning with the issue of importance to the country alters relative bargaining costs in a way that makes the country better off. This result may explain why the EU wishes to delay negotiations on agriculture or why developing countries prefer to delay environmental agreements until after agreements on free trade have been reached.

We note in closing that unanswered here is how the bargaining structure is determined. One possible answer is that it too is subject to negotiation.[10] Alternatively, it may be that these structures have been institutionalized through international arrangements or organizations. In this case, the analysis above will be useful for understanding these institutions and for determining who gains and loses from them.

References

[1] Abrego, Lisandro, et al., "Trade and Environment: Bargaining Outcomes from Linked Negotiations", *Review of International Economics* 9 (2001), 414-28.

Bagwell, Kyle and Robert Staiger, "Domestic Policies, National Sovereignty and International Economic Institutions", *Quarterly Journal of Economics* 116 (2001), 519-62.

Busch, Lutz-Alexander and Ignatius J. Horstmann, "Bargaining Frictions, Bargaining Procedures and Implied Costs in Multiple-Issue Bargaining", *Economica* 64 (1997), 669-80.

___________, "Endogenous Incomplete Contracts: A Bargaining Approach", *Canadian Journal of Economics* 32 (1999), 956-75.

Conconi, Paola and Carlo Perroni, "Issue Linkage and Issue Tie-In in Multilateral Negotiations", *Journal of International Economics* 57 (2002), 423-47.

Copeland, Brian and Scott Taylor, "Trade and Transboundary Pollution", *American Economic Review* 85 (1995), 716-37.

Fershtman, Chaim, "The Importance of the Agenda in Bargaining", *Games and Economic Behavior* 2 (1990), 224-38.

Horn, Henrik and Asher Wolinsky, "Worker Substitutability and Patterns of Unionisation", *Economic Journal* 98 (1988), 484-97.

Inderst, Roman, "Multi-Issue Bargaining with Endogenous Agenda", *Games and Economic Behavior* 30 (2000), 64-82.

Johnson, Harry G., "Optimal Tariffs and Retaliation", *Review of Economic Studies* 21 (1954) 142-53.

Jun, Byoung Heon, "Non-Cooperative Bargaining and Union Formation", *Review of Economic Studies* 56 (1989), 59-76.

Markusen, James R. "Cooperative Control of International Pollution and Common Property Resources", *Quarterly Journal of Economics* 89 (1975a), 618-32.

____________, "International Externalities and Optimal Tax Structures", *Journal of International Economics* 5 (1975b), 15-29.

________ and Randall Wigle, "Nash Equilibrium Tariffs for the US and Canada: The Roles of Country Size, Scale Economies and Capital Mobility", *Journal of Political Economy* 97 (1989), 368-86.

Rubinstein, Ariel, "Perfect Equilibrium in a Bargaining Model", *Econometrica* 50 (1982), 97-110.

Spagnolo, G., "Issue Linkage, Delegation, and International Policy Cooperation", manuscript, 2000.

7 Appendix

For Proposition 1, the structure of the proof is as follows. Since $s > c_1$ and $1 > c_2$, both surpluses are allocated under the unlinked structure. This allocation is necessarily inefficient (lies in the interior of $\mathcal{U}_L$) since neither agent obtains all of the surplus preferred by that agent. As a result, at least one of the 2 agents must gain from linking. To prove that both gain (at least weakly) from linking, we show that i) no point on $\mathcal{U}_L$ yielding agent 2 less utility than under the unlinked structure can be a Nash bargaining solution over $\mathcal{U}_L$ and ii) no point yielding agent 1 less utility than under the unlinked structure can be a Nash bargaining solution over $\mathcal{U}_L$.

To demonstrate these points, we consider the point on $\mathcal{U}_L$ that gives agent 2 the same utility as under the unlinked structure. We then compare the ratio of the agents' utilities to the slope of the utility frontier at this point and show that the ratio of utilities is greater or equal to (the absolute value of) the slope of $\mathcal{U}_L$. This fact implies that the Nash bargaining solution over $\mathcal{U}_L$ must give agent 2 at least as much utility as the unlinked structure. Analogously, we fix the point on $\mathcal{U}_L$ that gives agent 1 the same utility as under the unlinked structure and compare the ratio of utilities to the slope at this point. Again we show that this ratio is less or equal to (the absolute value of) the slope of $\mathcal{U}_L$ at this point, implying that the Nash bargaining solution over $\mathcal{U}_L$ must give agent 1 at least as much utility as the unlinked structure.

As a preliminary to proving the propositions, we provide the simple algebra for determining the points in $\mathcal{U}_L$ that yield utility equal to that from the unlinked structure. Suppose that agent 2's utility is to be set at $U_2^u = .5[b_2(1-c_2)+s-c_1]$ (2's utility in the unlinked game). Note that, were 2 to obtain all of S_2 and 1 all of S_1, then 2's utility would be $U_2 = b_2 - c_1$. If $.5[b_2(1-c_2)+s-c_1] < b_2 - c_1$, then 2's unlinked utility can be achieved by an allocation that gives 1 all of S_1 and some share of S_2. The previous inequality is satisfied if $1-c_2 < 2-(s+c_1)/b_2$. Agent 1's utility in this case can be found by solving for the value of y that yields agent 2 his unlinked utility. This value is defined by the equation $b_2y - c_1 = .5[b_2(1-c_2)+s-c_1]$; or $y = .5(1-c_2)+.5(s+c_1)/b_2$. Substituting this value of y into agent 1's utility function yields $U_1' = b_1s + .5(1-c_2) - .5(s+c_1)/b_2$. Since 1 has all of S_1 and some S_2, we are on that part of the utility frontier that is to the left of the kink. The slope there is $-1/b_2$; 2 gains under the linked structure if $U_1'/U_2^u > 1/b_2$.

If, by contrast, $1-c_2 > 2-(s+c_1)/b_2$, then agent 2 must get all of S_2 and some share of S_1 in order to achieve his unlinked utility. Now we solve for the value of x that gives agent 2 this utility level. In this case the reference utility point is to the right of the kink, so that the slope of the utility frontier is $-b_1$.

For the case in which we want to fix agent 1's utility at his unlinked level, $U_1^u = .5[b_1(s-c_1)+1-c_2]$, we proceed similarly. In particular, suppose we give all of S_2 to agent 2 and all of S_1 to agent 1. Then 1's utility is $U_1 = sb_1 - c_2$. If $.5[b_1(s-c_1)+1-c_2] < sb_1 - c_2$, then we can give 1 his unlinked utility by giving 2 all of S_2 and some share of S_1. This inequality is satisfied if $s-c_1 < 2s-(1+c_2)/b_1$. Agent 2's utility in this case can be found by solving for the value of x that yields 1 his unlinked utility. This value is defined by the equation $.5[b_1(s-c_1)+1-c_2] = sb_1x - c_2$; or

$x = .5[b_1(s - c_1) + 1 + c_2]/sb_1$. Substituting this value of x into 2's utility function yields $U_2' = b_2 + .5(s - c_1) - .5(1 + c_2)/b_1$. Since 2 has all of S_2 and part of S_1, we are on the part of the utility frontier that is to the right of the kink. The slope there is b_1; 1 gains under linking if $U_1^u/U_2' < b_1$. The case in which $s - c_1 > 2s - (1 + c_2)/b_1$ is determined analogously.

We prove here a slightly more general Proposition, which contains the result in Proposition 1 in the text.

Proposition 5 *If $s > c_1 > 0$ and $1 > c_2 > 0$, then the linked bargain yields strictly higher utility for both agents relative to the unlinked bargain. If $c_2 = 0$ and $s > b_2 - c_1$ then agent 1's utility strictly increases under the linked bargain while agent 2's utility is unchanged; if $c_1 = 0$ and $1 > sb_1 - c_2$ then 2's utility strictly increases while 1's utility is unchanged.*

Proof: Under separate negotiations, $U_1^u = .5[b_1(s-c_1)+1-c_2]$ and $U_2^u = .5[b_2(1-c_2)+s-c_1]$. Fixing agent 2's utility at $U_2^u = .5[b_2(1-c_2)+s-c_1]$, if $1-c_2 < 2-(s+c_1)/b_2$, then agent 1 gets all of S_1 and some share of S_2. Agent 1's utility is given by $U_1' = b_1 s+.5(1-c_2)+.5(s+c_1)/b_2$. Also, the slope of the utility frontier at this point is $1/b_2$. From above, what we need to check is that $\frac{1}{b_2} \leq U_1'/U_2^u = \frac{2b_1 s + 1 - c_2 - (s + c_1)/b_2}{b_2(1 - c_2) + s - c_1}$. This inequality is satisfied strictly if $2s(b_1 b_2 - 1) > 0$, which it is since $b_1, b_2 > 1$. In this case, then, agent 2 strictly gains from linking.

If $1 - c_2 > 2 - (s + c_1)/b_2$, then agent 1 gets none of S_2 and only some share of S_1. Agent 1's utility is given by $U_1' = .5[b_1(s - c_1) + b_1 b_2(1 + c_2)] - c_2$. Also, the slope of the utility frontier is b_1. Now we need to check that $b_1 \leq U_1'/U_2^u = \frac{b_1(s-c_1)+b_2b_1(1+c_2)-2c_2}{b_2(1-c_2)+s-c_1}$. This inequality is satisfied if $2c_2(b_1b_2-1) \geq 0$. If $c_2 > 0$ then the inequality is satisfied strictly since $b_1, b_2 > 1$; if $c_2 = 0$ then there is strict equality and agent 2 achieves the same utility as in the unlinked case. Since at least one agent must gain from linking, in this case agent 1 gets all of the gains. Note that, in this case, the condition $1-c_2 > 2-(s+c_1)/b_2$ specializes to $s > b_2 - c_1$, the condition of our Proposition.

Now, fixing agent 1's utility at $U_1^u = .5[b_1(s-c_1)+1-c_2]$, if $s-c_1 < 2s-(1+c_2)/b_1$, then agent 2 gets all of S_2 and some share of S_1. Agent 2's utility is given by $U_2' = b_2+.5(s-c_1)-.5(1+c_2)/b_1$. Also, the slope of the utility frontier at this point is b_1. From above, we need to check here that $b_1 \geq U_1^u/U_2' = \frac{b_1(s-c_1)+1-c_2}{2b_2-(1+c_2)/b_1+s-c_1}$. This inequality is satisfied if $2(b_1b_2-1) > 0$, which it is since $b_1, b_2 > 1$. In this case, agent 1 strictly gains from linking.

If $s-c_1 > 2s-(1+c_2)/b_1$, then agent 2 gets none of S_1 and only some share of S_2. In this case, 2's utility is given by $U_2' = .5[b_1b_2(s+c_1)+b_2(1-c_2)]-c_1$. Also, the slope of the utility frontier at this point is $1/b_2$. From above, we need to check here again that $1/b_2 \geq U_1^u/U_2' = \frac{b_1(s-c_1)+1-c_2}{b_1b_2(s+c_1)+b_2(1-c_2)-2c_1}$. This inequality is satisfied if $2c_1(b_1b_2-1) \geq 0$. If $c_1 \neq 0$, then this inequality is satisfied strictly (since $b_1, b_2 > 1$) and agent 1 is strictly better off; if $c_1 = 0$, then there is strict equality and agent 1 achieves the same utility as under the unlinked structure (agent 2 gets all of the gains). In this latter case, the condition $s-c_1 > 2s-(1+c_2)/b_1$ specializes to $1 > sb_1 - c_2$, the condition in our Proposition. **qed**

Proof of Proposition 2: Under the assumptions of the proposition, only S_1 is allocated under the unlinked structure. The utilities of agents 1 and 2 are $U_1^u = .5b_1(s - c_1)$ and $U_2^u = .5(s - c_1)$ respectively. With $c_2 > 1$, it may not be efficient to allocate both surpluses; as a result, the point (U_1^u, U_2^u) need not lie in the interior of the utility possibility set. To check this, we need only check whether there is a point on $\mathcal{U}_L$ that yields agent 1 utility U_1^u and agent 2 utility greater than U_2^u.

Consider an allocation that gives all of S_1 and a share $1 - y'$ of S_2 to agent 1 and that yields 1 utility of U_1^u. The value of y' under this allocation is the solution to the equation $b_1 s + 1 - c_2 - y' = .5b_1(s - c_1)$ and is given by $y' = .5b_1(s + c_1) + 1 - c_2$. If $y' \in (0, 1)$, then this allocation gives the point on $\mathcal{U}_L$ yielding agent 1 the same utility as under the unlinked structure. The value of y' lies on $(0, 1)$ if $s + 2/b_1 > 2c_2/b_1 - c_1 > s$. The second inequality is satisfied by our assumption on s; the assumption that $c_1(b_1 - 1/b_2) < c_2 - 1 < .5(s + c_1)(b_1 - 1/b_2)$ implies that the first inequality is satisfied. Agent 2's utility at this point is $U_2' = b_2 y' - c_1$ and this utility is larger than U_2^u as long as $(1 - c_2) + .5(s + c_1)(b_1 - 1/b_2) > 0$. Therefore, under the conditions of the proposition, the point (U_1^u, U_2^u) lies in the in the interior of the utility set and so the linked structure must make at least one agent better off.

To conclude the proof, we need only show that agent 1 is made worse off. Since the point on $\mathcal{U}_L$ yielding 1 the same utility as under the unlinked structure lies to the left of the kink, 1 is worse off if $1/b_2 < U_1^u/U_2'$. This inequality is satisfied as long as $1 - c_2 + c_1(b_1 - 1/b_2) < 0$. **qed**

Derivation of bargained outcome for S_1 in structure S_1 then S_2:

Let (x_s^*, x_s^{**}) be the offers on S_1 by agents 1 and 2 respectively in this sequential game. Then, the conditions defining equilibrium are:[11]

$$\begin{aligned} s(1-x_s^*) &= s(1-x_s^{**}) - (1-\delta)[s(1-x_s^{**}) + \delta b_2] \\ b_1 s x_s^{**} &= b_1 s x_s^* - (1-\delta)(b_1 s x_s^* + \delta). \end{aligned}$$

The limiting equilibrium is given by an appropriately defined Nash bargaining solution. From the above, this solution is given by the condition

$$b_1 \geq \frac{s b_1 x_s + 1}{s(1-x_s) + b_2},$$

where the inequality allows for the fact that the solution may be a corner solution in which $x_s = 1$. It can be checked that, if $b_2 > s + \frac{1}{b_1}$, the outcome is a corner solution.

Proof of Proposition 4: Consider the sequentially unlinked structure S_1 then S_2. If bargaining proceeds to S_2, then since $1 \geq c_2$, each agent obtains net share $.5(1-c_2)$. Should agreement be reached on S_1, the conditions defining the equilibrium offers, (x_s^*, x_s^{**}), are:

$$\begin{aligned} s(1-x_s^*) - c_1 + \delta b_2(1-c_2)/(1+\delta) &= \delta[s(1-x_s^{**}) - c_1 + \delta^2 b_2(1-c_2)/(1+\delta)] \\ b_1 s x_s^{**} + \delta(1-c_2)/(1+\delta) &= \delta[b_1 s x_s^* + \delta^2(1-c_2)/(1+\delta)]. \end{aligned}$$

Solving these equations for (x_s^*, x_s^{**}) and taking the limit as $\delta \to 1$, we obtain that agent 1's share of S_1 is given as

$$x_s = .5[s - c_1 + b_2(1-c_2)]/s - .5(1-c_2)/b_1 s.$$

Agent 1's share of S_1 under the unlinked structure is $.5(s-c_1)/s$. Since $s \geq c_1$, $1 \geq c_2$, 1's share is at least as large under this sequentially unlinked structure as long as $.5[b_2 b_1(1 - c_2) - 1 - c_2] \geq 0$, which it is since $b_2, b_1 > 1$. Since 1 obtains the same net share of S_2 under both structures, 1 weakly prefers this sequentially unlinked structure to the unlinked one as long as agreement is reached on S_1 in the sequentially unlinked case. Similarly, since agent 2 obtains a smaller share of S_1 under this sequentially unlinked structure and the same share of S_2, 2 weakly prefers the unlinked structure to this sequentially unlinked one as long as agreement is reached in the sequentially unlinked case. Agreement will be reached on S_1 as long as agent 2 obtains non-negative utility (agent 2 can always guarantee zero utility by never agreeing in the bargain on S_1). Agent 2's utility from the above agreement is $.5(s - c_1) + .5(1 - c_2)/b_1 > 0$ and so agreement is reached on S_1.

An analogous argument applies for the comparison of the sequentially unlinked structure S_2 then S_1 and the unlinked structure. **qed**

Endnotes

1. Our analysis draws on but also advances previous theoretical work on multiple issue bargaining. See especially, Busch and Horstmann (1997; 1999) and Inderst (2000)).

2. In these functions, units of measurement for S_1 and S_2 are also chosen so that 2's marginal utility from S_1 and 1's marginal utility from S_2 are both one.

3. The analysis here, and in what follows, shares similarities with work by Horn and Wolinsky (1988) and Jun (1989) in a labor union context. These papers examine whether two distinct sets of workers would prefer to bargain with a single employer as a joint union or two separate unions. Because each worker group only cares about wages to that group, joint versus separate negotiations comes down to a matter of how each structure affects a given groups threat point in bargaining. Here, by contrast, an agent's choice between linked and unlinked agendas comes down to the way that each agenda allows trade-offs across issues and how each affects an agent's bargaining costs.

4. This result is a generalization of one in Inderst.

5. An analogous result can be derived for the case in which linking makes agent 2 worse off.

6. Intuitively, what happens in this case is that s is sufficiently small relative to c_2 that the linked structure can provide agent 1 with the same utility level as the unlinked structure only if linking allocates all of S_1 and some share of S_2 to agent 1. In this case, the only gain to linking for 1 is that he can efficiently compensate agent 2 for c_1 through S_2. This efficiency gain is given by the expression $c_1(b_1 - 1/b_2)$. The gross

surplus that 1 loses from linking is given by $1 - c_2$. With $1 - c_2 + c_1(b_1 - 1/b_2) < 0$, agent 1 loses from linking.

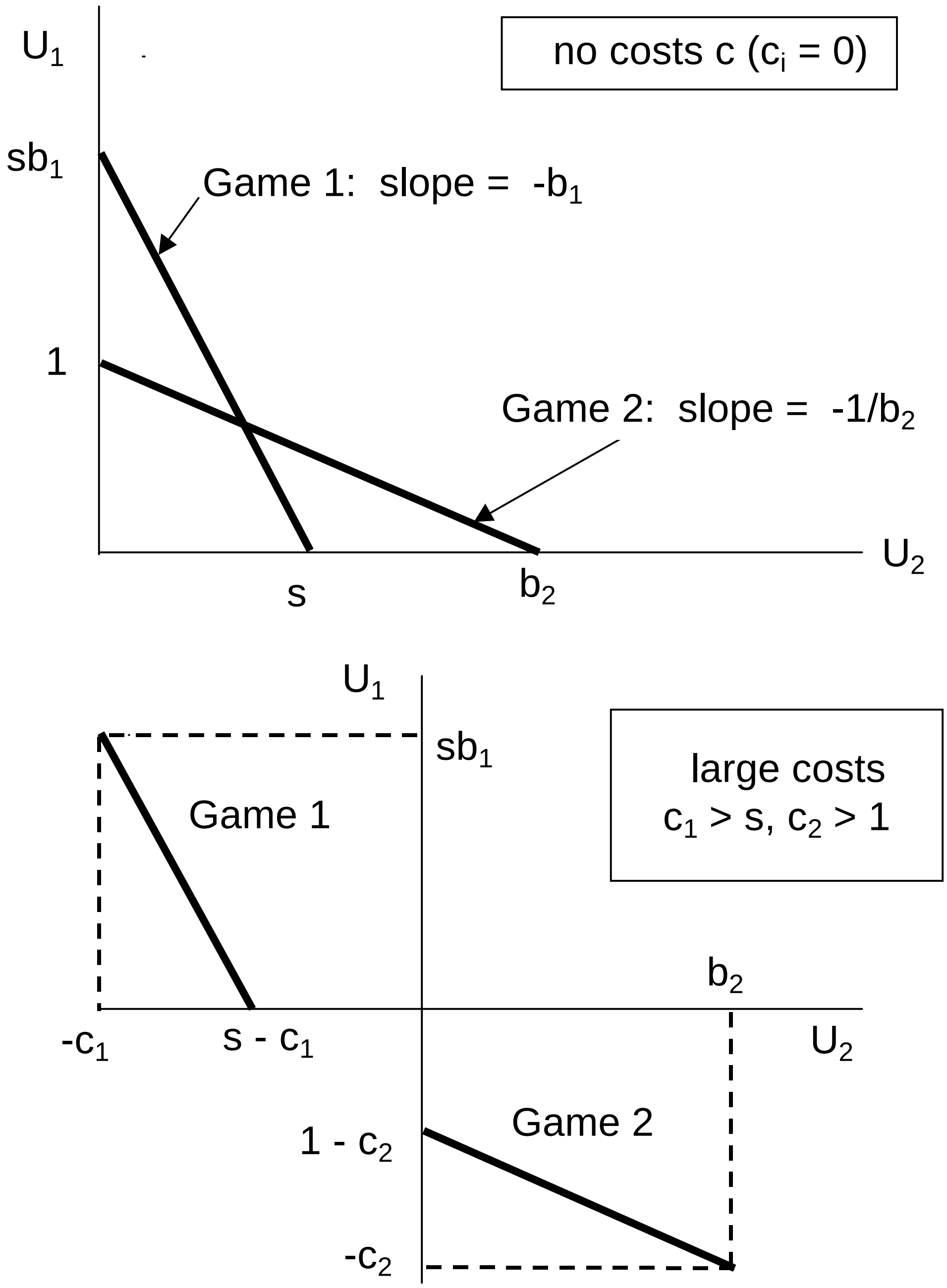
7. The analysis in this section draws heavily on previous work by Busch and Horstmann.

8. Just as an example, if $c_2 \geq 1$, then the sequentially unlinked structure in which S_1 is bargained first yields exactly the same allocation as the unlinked structure. The same is true of the sequential structure in which S_2 is bargained first when $c_1 \geq s$. In such cases the linked structure can dominate the unlinked structure and as a result, various sequentially unlinked structures.

9. Note that the assumption underlying this outcome – in each separate bargain, the level of the other tax is its status quo value – is consistent with the equilibrium.

10. This is the approach taken in Busch and Horstmann (1999).

11. The structure of offers and counteroffers assumed here is that, if bargaining on S_1 ends with agent 1 accepting an offer from agent 2, then agent 1 makes the first offer on S_2. Similarly, if bargaining on S_1 ends with 2 accepting an offer from 1, then 2 makes the first offer on S_2.



Notation: $U_1 = sb_1 - b_1U_2$ game 1

$U_2 = b_2 - b_2U_1$ game 2

Figure 1: Two symmetric games

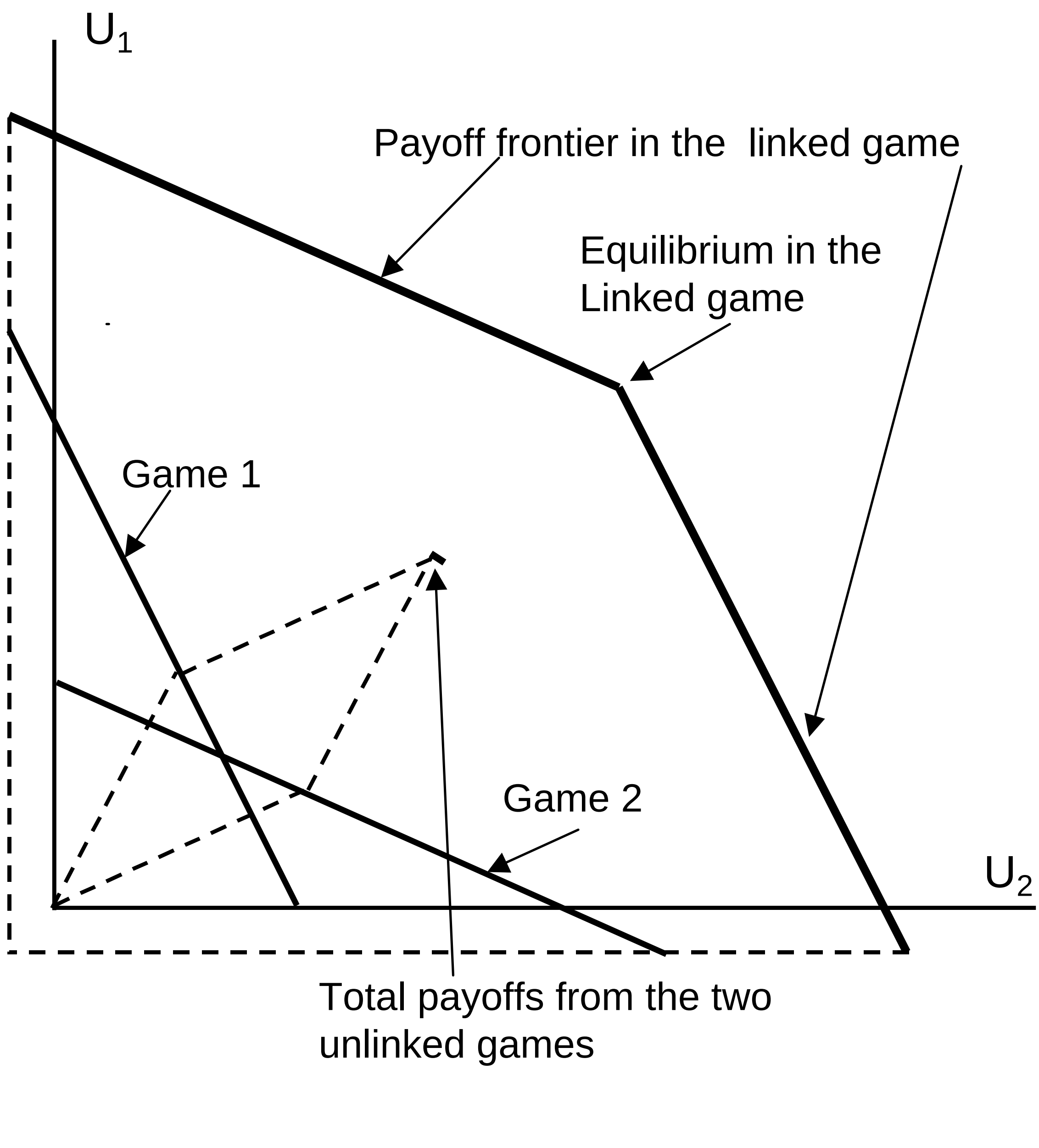
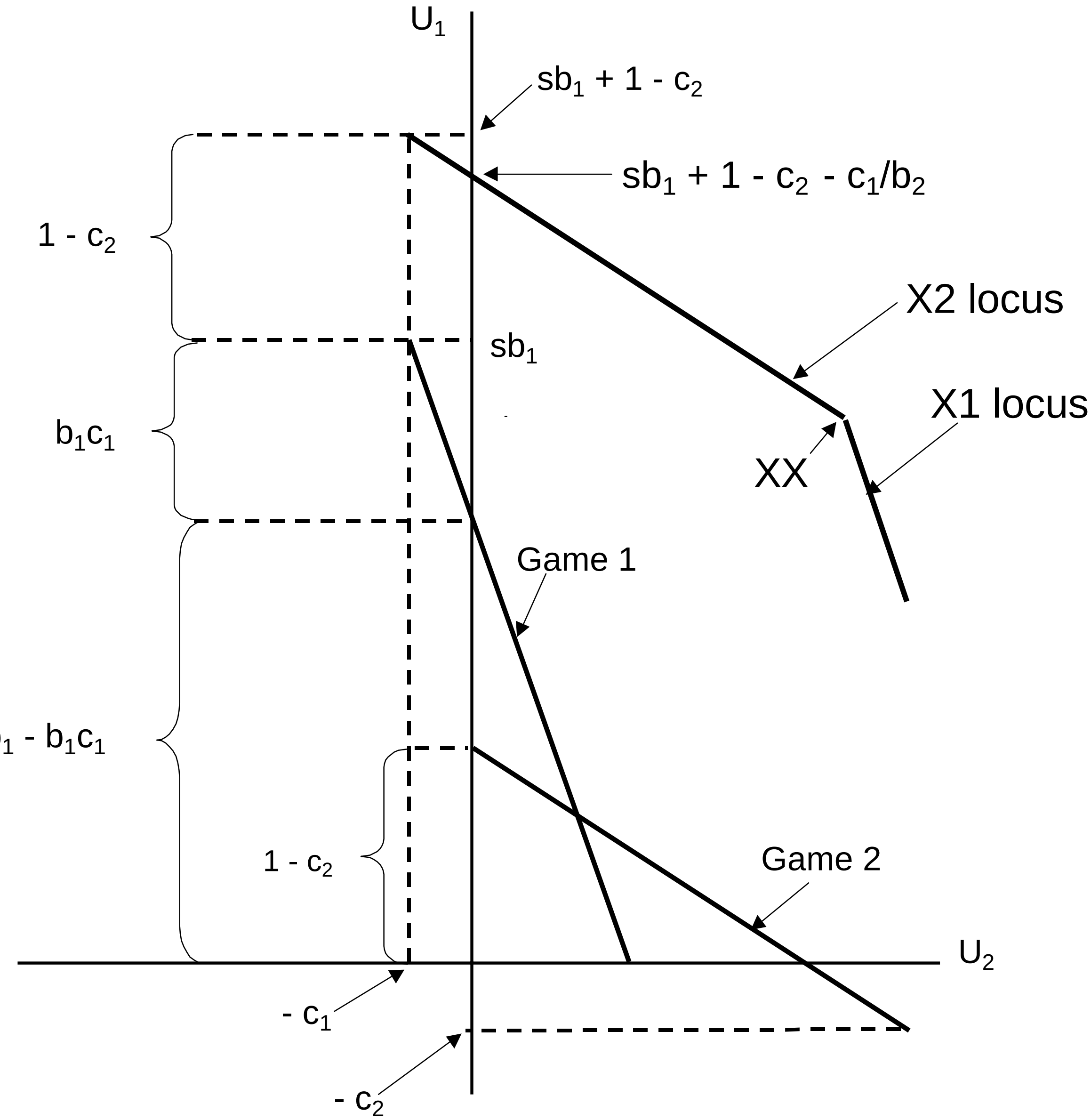


Figure 2: Payoff frontier in the linked game



Minimum payoff to player 1 in the linked game: $U_1^* = [sb_1 + 1 - c_2 - c_1/b_2]/2$

Sum of payoffs to player 1 in the two unlinked games $U_1' = [sb_1 + 1 - c_2 - c_1 b_1]/2$

Minimum Difference $U_1^* - U_1' = c_1(b_1 - 1/b_2)/2 >= 0$

Figure 3: Geometric interpretation and proof of Proposition 1

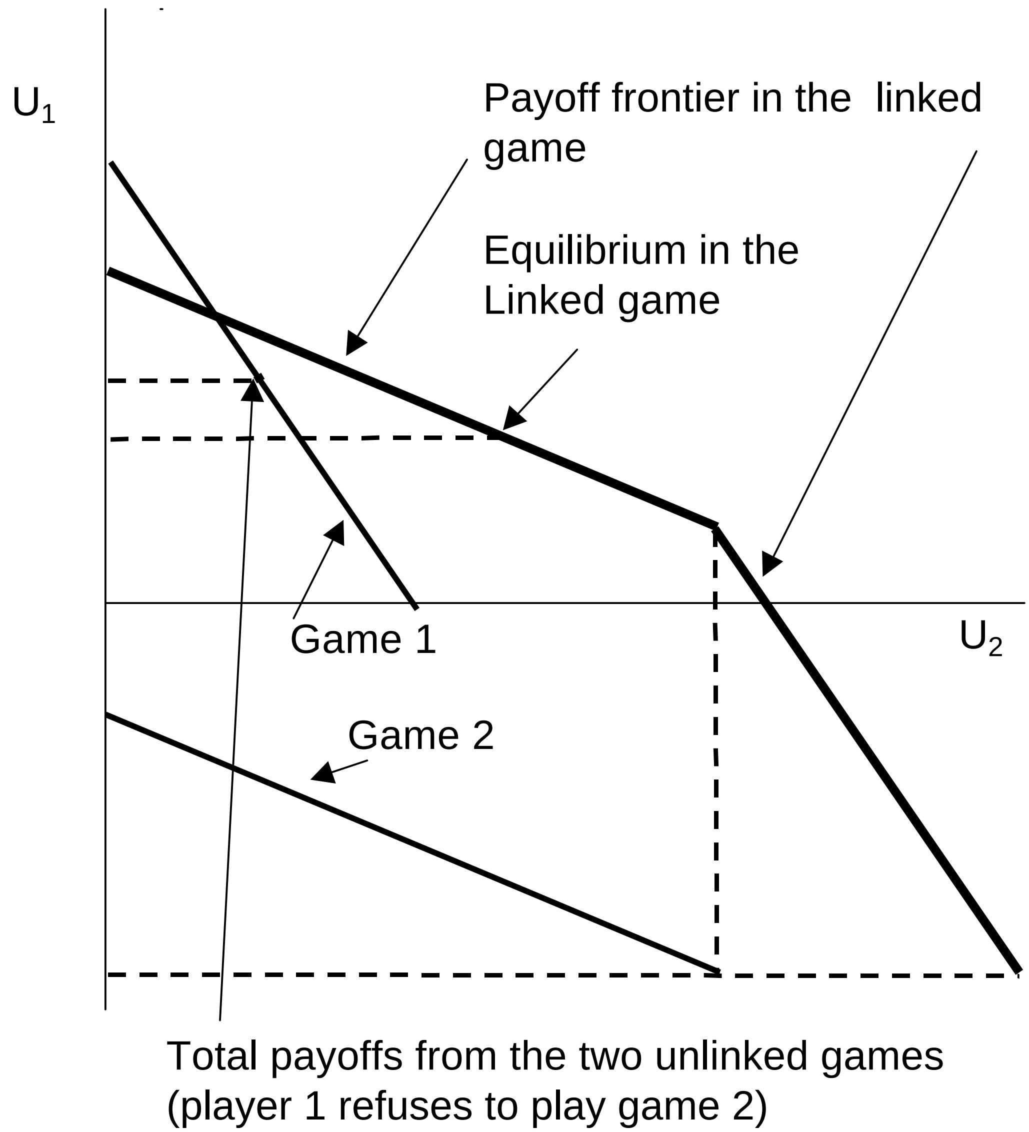


Figure 4: Linking worsens player 1's welfare

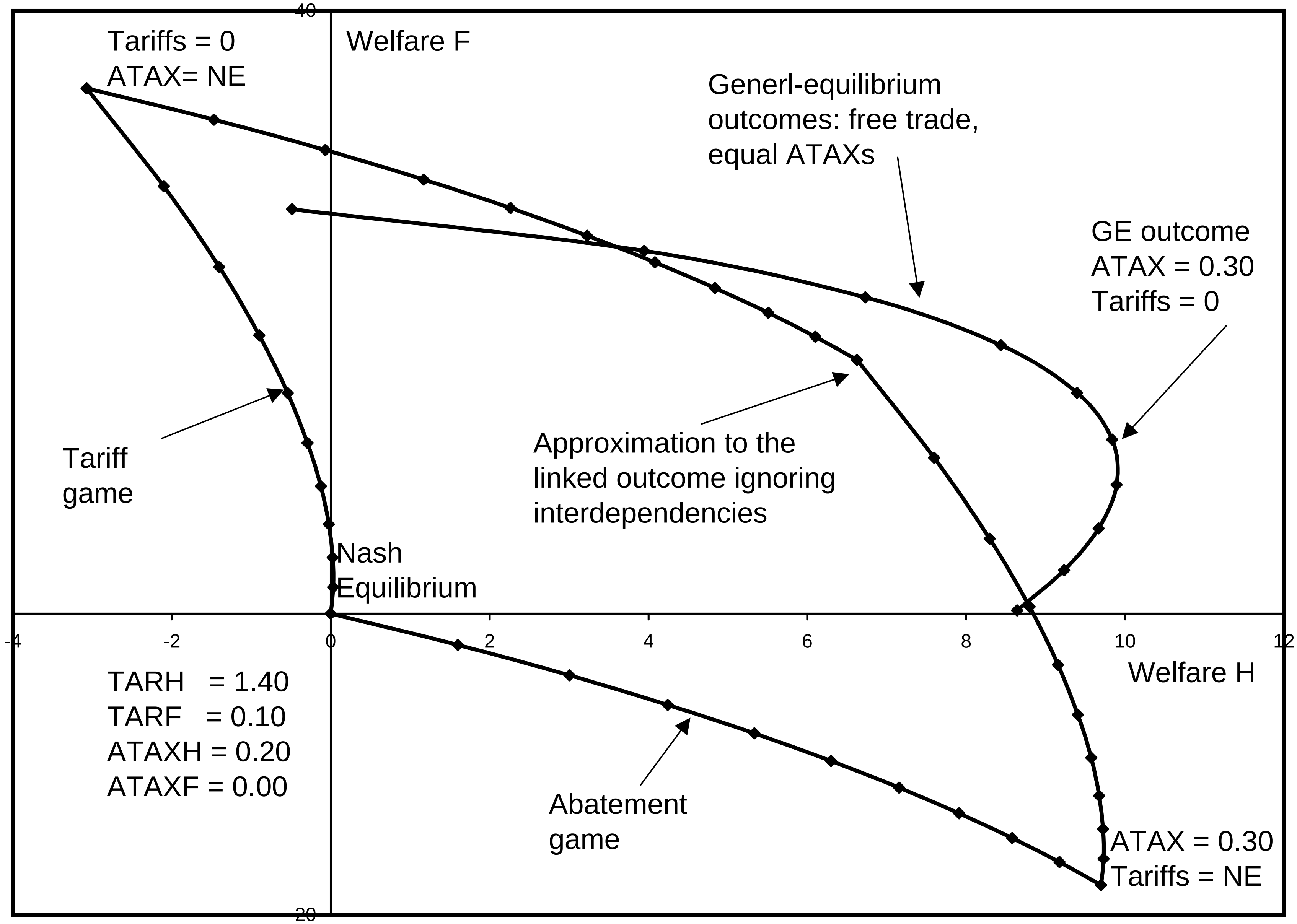


Figure 5: Linking tariff and environmental negotiations