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Linking Issues

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[Abstract] International negotiations on trade (e.g. GATT and TRIPS) have typically been of the package-form, and different issues have therefore been linked to each other. Trade issues have not been linked to e.g. environmental agreements in negotiations, however. This paper studies the outcome of linked bargaining, where two issues are simultaneously negotiated over by two countries. We notice that there always exist gains from linkages in bargaining, and that such linking will always occur in equilibrium if there is a pre-stage where the countries are bargaining over the agenda. The outcome under linked bargaining is compared with the outcome under separate negotiations, and the circumstances where a country will gain or lose from linking are characterized. The results help us to understand different countries' preferences for linkages in bargaining.

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1. Introduction

A range of international disputes has been subject to package-style negotiations. For example, this was the case for the previous GATT-rounds, where nothing was agreed upon before everything was agreed upon. However, there are no such linkages between issues in *different* GATT-rounds, nor do linkages between trade agreements and e.g. the Kyoto agreement exist. In some cases, different countries have very different opinions on which issues, if any, should be linked in a joint negotiation. For example, a hot current debate is whether to link labor standards to trade negotiations. These observations suggest that linkages are likely to affect the final agreement; that there may exist gains from linking issues; and that some parties may lose from linkages. But, who did really gain from linking GATT and TRIPS in the Uruguay round? The literature on international negotiations does not provide satisfactory answers to such questions.

In an interesting paper, Conconi and Perroni (2000) study multilateral bargaining where different issues can be tied-in, meaning that those agreeing on one issue must also agree on the other. They find that in some cases, such tie-in gives the same outcome as if the issues are agreed upon separately. In other cases tie-in will make an otherwise stable separate agreement unstable, since it is tied to another issue. The focus in that paper is not, however, whether the different parties will gain from linking different issues.

One reason why linking issues may be beneficial is that the incentives to agree on one issue are strengthened, if this agreement is a required condition for another (linked) agreement. Similarly, cheating in cooperation on one issue will be punished more if the countries use a linked trigger strategy, since cheating on one issue then destroys the cooperation on other issues as well. Spagnolo (1999) and Limão (2000) analyze the effects of using linkages in this respect and find that cooperation is strengthened particularly if the issues are (strategic) complements.

However, none of these papers discuss another central benefit from linking issues, namely that it typically provides a potential Pareto improvement because two parties can exchange “favors” in the following way: party 1 can do party 2 a favor by offering a better agreement for 2 on the issue of the greatest importance to 2, if 2 simultaneously offers 1 a better agreement on the issue of the greatest importance to 1. Such exchange of favors is at the heart of the reciprocity condition in international negotiations. While Tollison and Willett (1979), and Sebenius (1983) discuss such benefits and costs of linking more informally, it is quite remarkable that these arguments have not been formalized earlier.

This paper analyzes these effects of linkages in international negotiations. After formalizing a 2x2 bargaining model in section 2, section 3 analyzes the linked equilibrium and compares it to the outcome where the issues are negotiated separately. We notice that linkages typically provide a potential Pareto improvement and that they will always be made if there is a pre-stage where the countries are bargaining over whether the issues should be linked. The question in focus, however, is who will gain and who will lose from such linkages. We find two conditions, each sufficient for a country to gain from linkages. If none of the conditions are fulfilled, however, the country will lose from linking the issues. We proceed by doing some comparative statics with respect to the position of the Pareto frontier. This frontier is likely to shift if e.g. non-tariff measures are included in the negotiations. The resulting conditions are helpful in understanding different countries' preferences for linkages, and how these can be modified.

In stating these results, we rely on the Nash bargaining solution and assume that the bargaining frontier of each issue can be approximated by a linear frontier. While section 4 discusses how these assumptions may be relaxed, we do not include a non-cooperative analysis of the bargaining game. In a more structural model, Fershtman (1990) suggests that the internal order of a sequence of linked issues in bargaining is of great importance as well.

Horstmann, Markusen and Robles (2000) approach similar questions from the same angle as I do in this paper. Thus, the two papers have certain overlapping results, but have been developed independently and - until recently - without knowledge of each other. It is stated in the text on which points our results overlap.

2. Bargaining and Linking

This section defines concepts and makes some assumptions. The next section relies on these preliminaries to analyze the linked agreement and who will gain from linking issues. The analysis assumes two parties, 1 and 2, and two issues, A and B. To fix ideas, however, it might be useful to interpret issue A as tariff reductions in agriculture (GATT), while B is the length (or the extent) of intellectual property rights patents (TRIPS). Party 1 might be interpreted as less-developed countries (LDCs) and party 2 as industrial countries.

2.1. Bargaining and Solutions

Let us first define a bargaining problem and a bargaining solution, as these concepts are used in the literature (see e.g. Mas-Colell et. al., 1995).

Definition 1: *A* <u>*bargaining problem*</u> *is a set* (Ω, D)*, where D is the von-Neumann-Morgenstern utility vector if there is disagreement, and* Ω *is the set of possible utility vectors if the parties do reach an agreement.*

Definition 2: *A* <u>*bargaining solution*</u> *is a rule assigning a solution vector* $f(\Omega, D)$ *Î* Ω *to every bargaining problem* (Ω, D)*.*

Thus, a bargaining problem is defined by the extent to which the parties can benefit from the different kinds of agreements. Let us now make some assumptions on the bargaining problem and the bargaining solution.

2.2. The Nash Bargaining Solution

The Nash bargaining solution is the solution most extensively used in the literature. It is the unique solution, given five appealing axioms (Nash, 1950), and is defined as follows:

Definition 3: *The* <u>*Nash Bargaining Solution*</u> *to a two-party bargaining problem (W,D) is* $\underset{U\in\Omega}{ArgMax}(U_1 - D_1)(U_2 - D_2)$

While capital letters (including superscripts) denote vectors, subscripts denote elements in the vector. One of the axioms supporting the Nash bargaining solution is that it is independent of utility origins. Thus, we can normalize the bargaining problem such that $D=0$ (meaning $D_1=D_2=0$), which implies that W is the set of additional utilities from the agreement, relative to no agreement. Suppose U_2£$a(U_1)$, where $a(.)$ denotes the Pareto frontier of issue A. Using definition 3 to calculate the Nash bargaining solution gives,

$$-a'(U_1) = \frac{U_2}{U_1} \tag{1}$$

if $a(.)$ is differentiable at this point. This is Proposition 2.1 in Muthoo (1999). If holding the Nash product $U_1U_2=\underline{U}$ constant, isoquant curves $U_2=\underline{U}/U_1$ can be drawn for any $\underline{U}$. Let us denote such a curve through a point $U=(U_1,U_2)$ by $I(U)$, and let $I'(U)$º$-U_2/U_1$ be the slope of the curve at this point. Thus, if U is the Nash bargaining solution, $I'(U)=-U_2/U_1=a'(U_1)$ if $a(.)$ is differentiable at this point. If $a(.)$ is not differentiable at U, $I(U)$ is a tangent to the possibility set at U if:

$$a'(U_{1-}) \leq -\frac{U_2}{U_1} \leq a'(U_{1+}) \tag{2}$$

This is Proposition 2.2 in Muthoo (1999). From equation (1), we see that if 2 benefits four times as much as 1 from the agreement in equilibrium, such that the right-hand side of (1) is 4, then the (left-hand side) trade-off between 2's and 1's utilities in equilibrium should also be four to one: 2 increases his utility by four marginal units if 1 reduces hers by one marginal unit. This property follows from two of Nash's axioms, namely "independence of utility units" (which means that we can redefine the utility scale such that $-a'=1$) and "symmetry" (which implies that $U_1=U_2$ if $-a'=1$).

Even though I will use the Nash bargaining solution rather mechanically, it has several non-cooperative foundations (see section 4). One interpretation, due to Rubinstein, Safra and Thomson (1992), is worth mentioning in this context. The Nash bargaining solution is the only equilibrium of a game where each party can suggest and demand an alternative to a "convention" (the equilibrium), and where there is a given possibility that bargaining will break down after each such request. This helps us interpret equation (1): if 2 gains four times the utility of the agreement than 1 in equilibrium, 2 also requires four times as many utility units to run the risk of breaking down the bargaining by suggesting an alternative. Because of its nice properties and interpretations, we will assume:

Assumption 1: *The Nash bargaining solution is the bargaining outcome.*

Let N^A denote the Nash bargaining solution of issue A, if A is negotiated separately.

2.3. A Linear Approximation of the Bargaining Problem

For the analysis, we will make another simplifying assumption, namely that the Pareto frontier of each issue is linear.

Assumption 2: *The Pareto frontier of issue A is the set of all convex combinations of vectors A^1 and A^2.*

Corners A^1 and A^2 are located such that 1 prefers the corner-outcome A^1, since $A_1^1 > A_1^2$, and 2 prefers the corner-outcome A^2, since $A_2^2 > A_2^1$. Let s_V denote the slope of an arbitrary vector V, and define $s_A \equiv -s_{(A1-A2)} > 0$ to be the absolute value of the slope of the Pareto frontier of issue A. We assume the default vector to be $D=0 \in W$. Then, the bargaining solution can be of three types: either an interior point on the frontier or one of the two corners. From (1) and (2) we get:

Proposition 1: *If*
a) $s_{A1} < s_A < s_{A2}$, *then* $s_{NA} = s_A$ *and the solution is interior;*
b) $s_{A2} < s_A$, *then* $N^A = A^2$;
c) $s_A < s_{A1}$, *then* $N^A = A^1$.

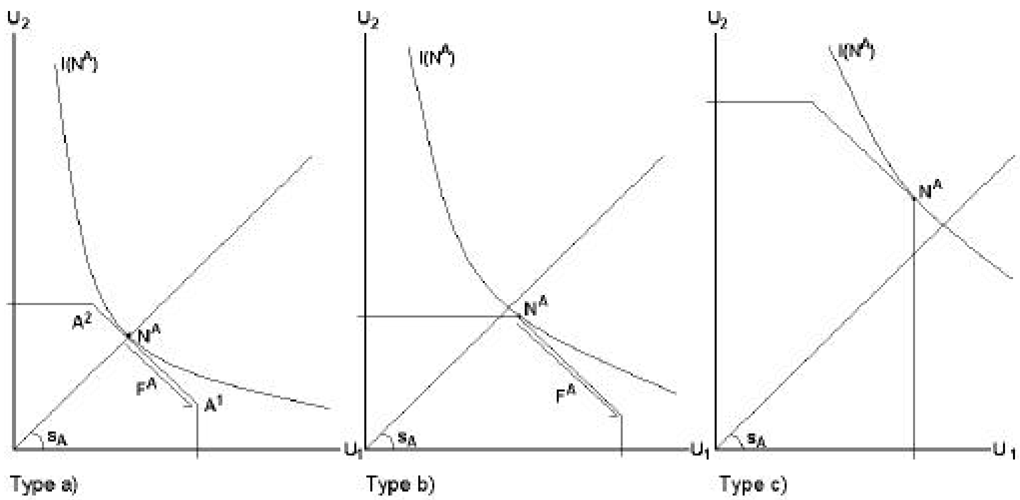

Figure 1: *Possible equilibria*

Symbols for issue *B* are symmetrically defined. Assume $s_A < s_B$ such that the absolute value of the slope of frontier *A* is smaller than the slope of frontier *B*. Hence, the marginal location on frontier *A* is relatively more important for 1 than the marginal location of frontier *B*, relative to 2's preferences. Thus, we can define 2's potential additional concession, or "favor", to 1 as $F^A \circ A^1\text{-}N^A$ as illustrated in Figure 1, and similarly, $F^B \circ B^2\text{-}N^B$. If we use ordinal utility functions, the exact trade-off s_A between 1's and 2's utilities has no meaning, since it can be changed by redefining 1's utility. This, however, would change s_B proportionally, so that $s_A<s_B$ has a clear meaning, even if using ordinal utility functions. In our example, some tariff reductions in agriculture (to point A^2) is good for both parties, while further liberalization becomes (politically) costly for the industrial countries. The less-developed countries prefer zero tariff (A^1), however. Similarly, some property rights protection is good for both parties (to point B^1) because it gives larger incentives to R&D, while further protection hurts less-developed countries and benefit industrial countries (to point B^2). $s_A<s_B$ implies that for less-developed countries, tariff reductions in agriculture are marginally more important than the length of property rights protection, relative to the preferences of industrial countries.

2.4. What are Linkages?

Since the literature on linking bargaining issues is small, there is no standard definition for linkages. For our purpose, the following definition is natural:

Definition 4: *(W^A,D^A) and (W^B,D^B) are <u>linked</u> in (Ω,D) where*

$$\Omega = \left\{ U : U = U^A + U^B,\ \ U^A \in \Omega^A, U^B \in \Omega^B \right\} \text{ and } D=D^A+D^B.$$

Note that Definition 4 rules out that the value of one bargaining problem depends on the outcome of another bargaining problem. The utility sets W^A and D^A are not functions of the outcome of bargaining problem *B*, and visa versa. Issues *A* and *B* are therefore neither complements nor substitutes in 1's and 2's preference functions. Thus, we have made the following assumption:

Assumption 3: *Bargaining problems A and B are independent.*

If *A* and *B* are linked, we will denote their outcomes L^A and L^B and aggregated $L \circ L^A+L^B$. This is to be compared with the aggregated outcome under separate negotiations, $N \circ N^A+N^B$.

3. Who Gains from Linking?

The previous section defined concepts and made some assumptions. This section uses these preliminaries to study when a party will gain or lose from linking issues.

3.1. The potential Gain from Linkages

There are several reasons why linkages may be beneficial. Agreeing on *A* (e.g. trading technical equipment) may not be worthwhile if there is no agreement on *B* (e.g. technical standards), and visa versa. Assumption 3 rules out such complementarity, however. In our simple model, there are still possible gains from linking, since the parties may exchange favors if they disagree on the relative importance of the issues. Since $s_A<s_B$, 1 can offer 2 a better agreement on issue *B*, if 1 gets a better agreement on issue *A*. Both will then be better off. If the Pareto frontiers $a(.)$ and $b(.)$ are differentiable, we can state:

Proposition 2: *Under Assumptions 1 and 3, there exists a Pareto improvement of linking issues A and B if* $a'(N^A_1) \neq b'(N^B_1)$.

Proof: The outcome $(U_1,U_2)=(a(U^A_1)+b(U^B_1),\ U^A_1+U^B_1)$ is Pareto optimal if and only if $a(U^A_1)+b(U^B_1)$ is maximized subject to $U^A_1+U^B_1=k$, where k is a constant. This problem immediately gives the first-order condition $a'(U^A_1)=b'(U^B_1)$. *QED*

This means that the slopes of $a(.)$ and $b(.)$ must be equal at the agreement points, otherwise there exist Pareto improvements by giving 1 more on one issue and 2 more on the other. When *A* and *B* have linear Pareto frontiers, there will always be gains from linkages, unless the potential exchange of favors is already exhausted:

Proposition 3: *Under Assumptions 1-3, there exist Pareto improvements of linking issues A and B if and only if* $F^A>0$ *and* $F^B>0$.

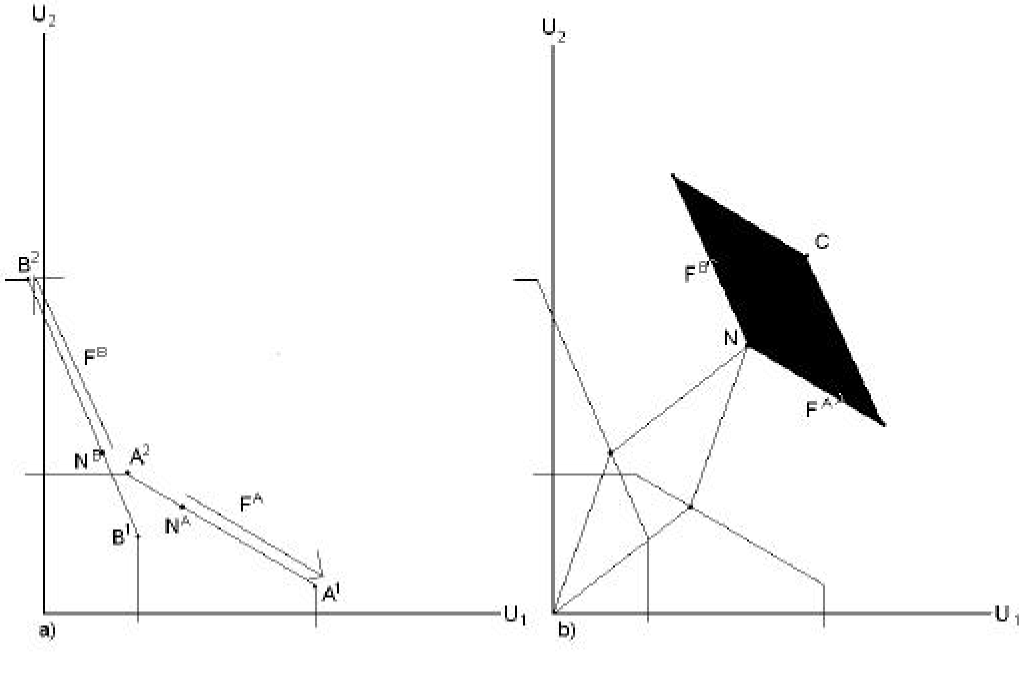

Figure 2: *N is Pareto dominated, and there exist gains from linking*

Many readers will recognize a similarity to the gains from trade in a Ricardian trade model. Also in a Ricardian model there exist gains from trade if and only if the slopes of the production possibility frontiers are different. Moreover, in section 3.3., I add the frontiers exactly as in a Ricardian model. There are two crucial differences, however: first, on the two axes in Figure 2, we have utilities of *both* bargaining parties, not two production levels in *one* single country as in the Ricardian model. Second, the outcome of trade in Ricardian models is determined by equilibrium prices, such that a party will gain from integration if the world price is different from the autarky price. If prices are the same, the country is indifferent to integrating or not. In our model, the outcome is determined by bargaining instead of equilibrium prices and, as will be shown, it is possible that a party can lose from linking. Because of these differences, we cannot use results from the Ricardian trade theory literature.

3.2. Linking in Equilibrium?

As shown above, there generally exist Pareto improvements from linkages. As will be shown below, however, it might be that in equilibrium, one of the parties loses while the other benefits from linking. In such cases, there will be a dispute when the bargaining agenda is defined, since the agenda defines whether the issues will be linked in the negotiations. Suppose that there is a pre-stage where the parties are bargaining over whether *A* and *B* should be linked. What will be the outcome of this bargaining over the agenda?

The answer turns out to be simple. When parties are simultaneously bargaining over two issues, they can obviously still agree on outcome *N* as in the case with no linking. But if $L \neq N$, they do not, which implies $U_1^L U_2^L > U_1^N U_2^N$ from Definition 3, with strict inequality, since *W* is convex. Note that this implies that both parties cannot lose from linking. In the pre-stage, the parties anticipate outcome *N* if the issues are not linked, and *L* if they are linked. Thus, a bargaining over the agenda is, in fact, a bargaining over *N* and *L*. Since $U_1^L U_2^L > U_1^N U_2^N$, linking will always occur in equilibrium.

Proposition 4: *Under Assumption 1, issues will be linked in equilibrium.*

To understand when the different parties oppose or support linking, a more careful analysis must be carried out.

3.3. The Linked Equilibrium

The linked Pareto frontier of *A* and *B* is derived in Figure 3. The maximum utility 1 can get is by the corner-outcome $C^1 \equiv A^1+B^1$. In our example, this corresponds to zero tariffs on agricultural products and the less-developed countries' preferred protection for intellectual property. If 1 then reduces her utility marginally, 2 increases his utility most, if we move along the B-frontier (increase property rights protection) instead of the *A*-frontier (increase tariffs), since $s_B>s_A$. But at the corner $C \equiv A^1+B^2$, 2's "preferred" issue *B* is taken to his preferred point. A larger utility for 2 then requires that 1 also gives 2 favors at issue *A*, with the trade-off s_A. At $C^2 \equiv A^2+B^2$, however, the outcome of both issues is maximum favorable to 2.

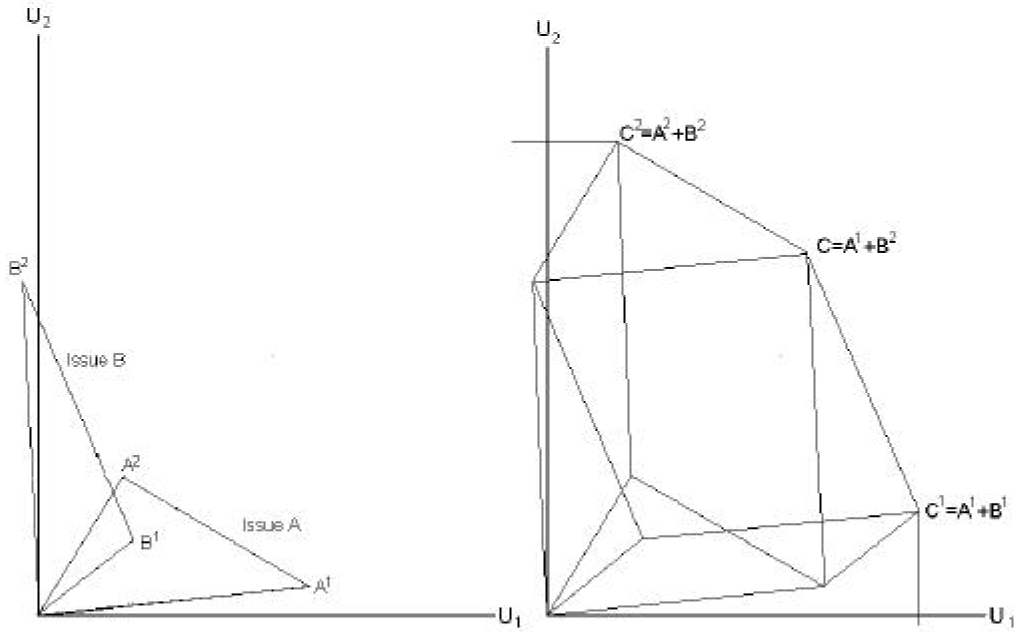

Figure 3: *Constructing the linked Pareto frontier*

There are five possible sets of bargaining solutions: *L* can be one of the three corners; interior on the line between *C* and C^1; or interior on the line between *C* and C^2. At $L=C$, issue *A* is taken to 1's preferred point and issue *B* to 2's preferred point. For this to be an equilibrium, I(C) must tangent the frontier at *C*. From equation (2), this implies that $s_B>s_C=s_L>s_A$. Similarly, from equations (1) and (2), an interior solution *X* between *C* and C^1 requires $s_X=s_B$; an interior solution *Y* between *C* and C^2 requires $s_Y=s_A$; a corner solution at C^1 requires $s_{C1} \geq s_B$ and a corner solution at C^2 requires $s_{C2} \leq s_A$. These potential solutions are illustrated in Figure 4 and summarized as:

Proposition 5: *Suppose Assumptions 1-3 hold. If*

a) $s_A<s_C<s_B$*, then* $L=C$*;*
b) $s_C<s_A<s_{C2}$*, then* $s_L=s_A$*,* $L^B=B^2$*, while issue A is not taken to the extreme;*
c) $s_{C1}<s_B<s_C$*, then* $s_L=s_B$*,* $L^A=A^1$*, while issue B is not taken to the extreme;*
d) $s_B<s_{C1}$*, then* $L=C^1$*;*
e) $s_{C2}<s_A$*, then* $L=C^2$ *.*

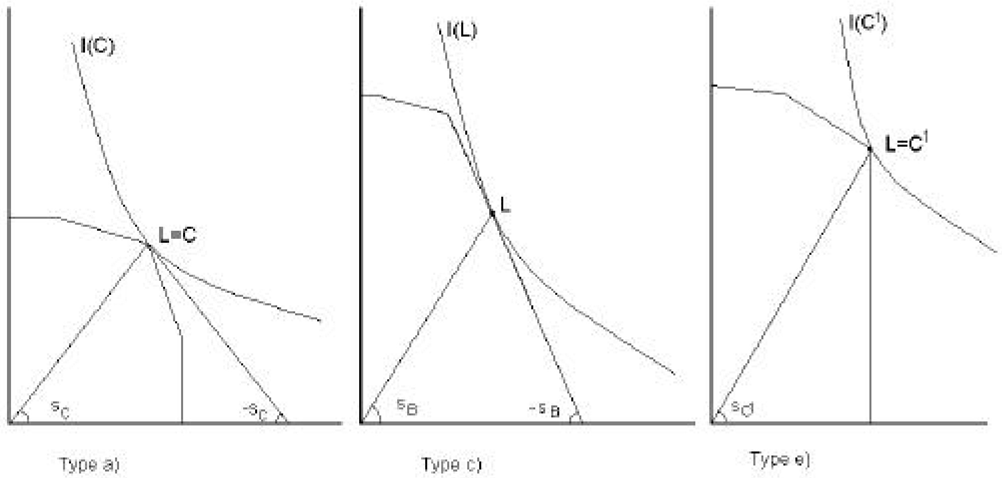

Figure 4: *Possible equilibria*

In all five cases, at least one favor is taken to the extreme. Issue *A* is taken to 1's preferred point A^1 for all solutions between *C* and C^1, i.e. if 2's utility relative to 1's utility in equilibrium is large relative to the slope of issue *A* ($s_L \geq s_A$). The potential benefit for 1, F^A, will therefore be exhausted if and only if 1 does not benefit too much relative to 2 in the agreement, relative to the slope of F^A. In our example, as well, it is likely that industrial countries are reluctant to offer less-developed countries considerable tariff reductions in agriculture, if they expect the LDCs to benefit most on the agreement overall anyway.

3.4. Who Benefits from Linking?

Let us now compare the linked outcome L with the non-linked outcome N, to see who gains and who loses from linking in different circumstances. This will be analyzed under the following assumption:

Assumption 4: *For each issue $J \in \{A,B\}$, the Pareto frontier is differentiable at N^J.*

This means that the outcome under non-linked bargaining is of type a) in Proposition 1 for both issues. Since our linear bargaining frontiers are approximations for a concave and differentiable frontier, this is a likely assumption.

Lemma 1: *Under Assumptions 1-4, L must be of types a), b) or c) in Proposition 5.*

Proof: $N=N^A+N^B$, so $s_A=s_{NA}<s_N<s_{NB}=s_B$. Moreover, C^1 gives 1 more and 2 less utility than *N*, so $s_{C1}<s_N$. Therefore, $s_{C1}<s_B$, which contradicts the requirements in Proposition 5 d). A similar argument shows that e) is not possible either. *QED*

It is then easy to prove a sufficient condition for when a party will benefit from the linkage:

Lemma 2: *Under Assumptions 1-4, 1 benefits from linking if* $F_1^A + F_1^B > 0$.

Proof: $C_1 - N_1 = F_1^A + F_1^B > 0$ so if L is of type a), 1 benefits from the linkage. C^1 is even better for 1, so that if L is of type c), 1 also benefits. Suppose that 1 loses on the linkage, such that the equilibrium must be of type b). It then follows from the discussion of Proposition 5 that $s_L = s_A$. Thus, if L is to the left of N, such that 1 loses, it must also be below N, since $s_L = s_A < s_N$. This implies that both 1 and 2 lose on the linkage, which is a contradiction. *QED*

Thus, if 2's potential favor to 1 on issue A, F^A, is large compared to favor F^B, then 1 benefits from the linkage. This is reasonable: 1's motivation for linkage is that 2 can offer more concessions on the issue that is most important for 1. The larger this potential favor is, relative to the favor to 2, the more likely 1 is to benefit from linking.

If $F_1^A + F_1^B < 0$, 1 is better off with N than with C. But it is not clear that $L=C$, so Lemma 2 gives a sufficient, but not necessary, condition for when 1 will benefit from the linkage. In fact, if F^A is sufficiently large, 1 will *always* benefit from the linkage[1]:

Lemma 3: *Suppose that Assumptions 1-4 hold, and that* $F_1^A + F_1^B < 0$. *1 benefits (loses) from linking if and only if* $A_2^1 < 0$ *(>0).*

Proof: Suppose $A_2^1 = 0$. Then, $F_1^A = N_1^A$ as in Figure 9 below. C must then be located on the ray x in Figure 5 , which crosses ray z of slope s_A at Y, such that $Y_1 = N_1$. Thus, $s_C > s_B$ and it follows from Proposition 5 that the solution is of type b). Thus, $s_L = s_A$ implying that $L=Y$. A similar argument shows that if $A_2^1 > 0$, F^A is shorter and the intersection point Y between x and z will be such that $Y_1 < N_1$ and 1 1oses on linkage. If $A_2^1 < 0$, F^A is longer and Y will be further to the left of z, and 1 benefits from the linkage, no matter the length or the slope of F^B. *QED*

[1] Proposition 2 B in Horstmann, Markusen and Robles (2000) gives a similar result: namely that $A^1_2 < 0$ and $B^2_1 < 0$ are sufficient conditions for linking to be a Pareto improvement.

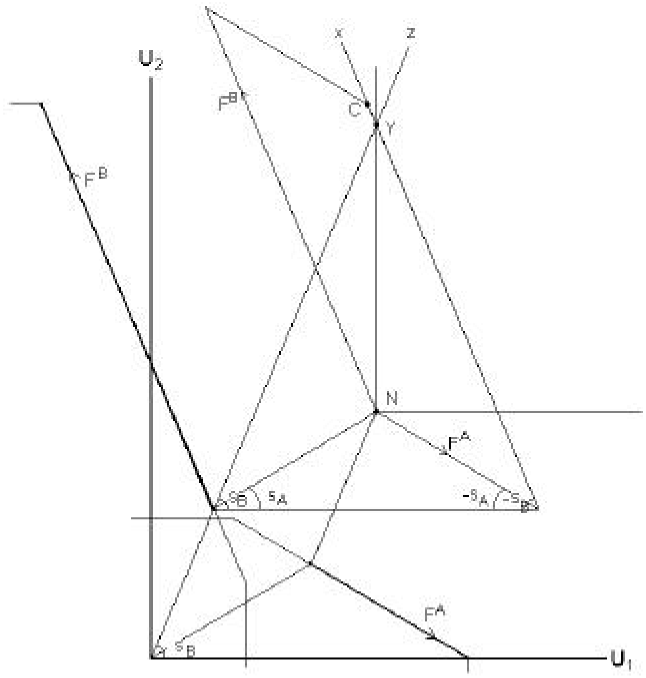

Figure 5: *If* $A_2^1 \leq 0$, *1 cannot lose on linking*

Combined, Lemma 2 and 3 imply:

Proposition 6: *Suppose that Assumptions 1-4 hold.*
1 gains (loses) from linking if and only if $F_1^A > (<) Min\{-F_1^B, N_1^A\}$.
2 gains (loses) from linking if and only if $F_2^B > (<) Min\{-F_2^A, N_2^B\}$.

Thus, if the potential favor to 1 is sufficiently large ($F_1^A > N_1^A$, such that the potential favor to 1 is larger than 1's benefit from issue *A* isolated), then 1 always benefits from linking. If F^A is shorter, 1 still benefits from linking if 1 is better off in the corner-solution *C* than in the non-linked outcome *N* (this does not imply that *L*=*C*, however). 1 loses from linking, however, if the potential favor to 1 is small ($F_1^A < N_1^A$), and if, simultaneously, the potential favor to 2 is large ($-F_1^B > F_1^A$). Therefore, we have two conditions that are simple to interpret. Each condition is sufficient, and at least one is necessary, for 1 to benefit.

For our example, these results indicate that less-developed countries were likely to gain from linking GATT and TRIPS if i) industrial countries are worse off with a zero tariff on agricultural products compared to no agreement on agriculture, or if ii) the LDCs themselves are better off with no tariffs and full protection of property rights than with the outcome from separate negotiations.

It is fruitful to illustrate some examples. For many issues, there is no conflict of interest: the bargaining question is whether to include the issue, not *to what extent* it should be included. If *A* is of this special case, we have $N_1^A = A_1^1 \Rightarrow F^A = 0$. Then, from Proposition 6, 1 cannot gain from linking, and 1 will lose from linking if and only if $F^B \neq 0$:

Corollary 1: *Suppose that Assumptions 1-4 hold. If* $F^A = 0 \neq F^B$, *1 loses and 2 benefits from linking.*

This follows directly from Lemma 3 and is illustrated in Figure 6. Thus, if issue *A* is relatively more important for 1, but there is no potential favor that 2 can give to 1 on this issue, 1 loses from linking since she has to give more favor to 2 on issue *B*. In our example, suppose that if the parties agree to include agriculture, then the level of tariffs is bound to be the same as for other industrial products. Then, the results above show that less-developed countries will lose from linking GATT and TRIPS. The reason is that GATT is so much more valuable for LDCs than for industrial countries, that the latter can pressure the former to accept more protection for intellectual property rights: if they do not agree on this issue, there will not be an agreement on agriculture either.

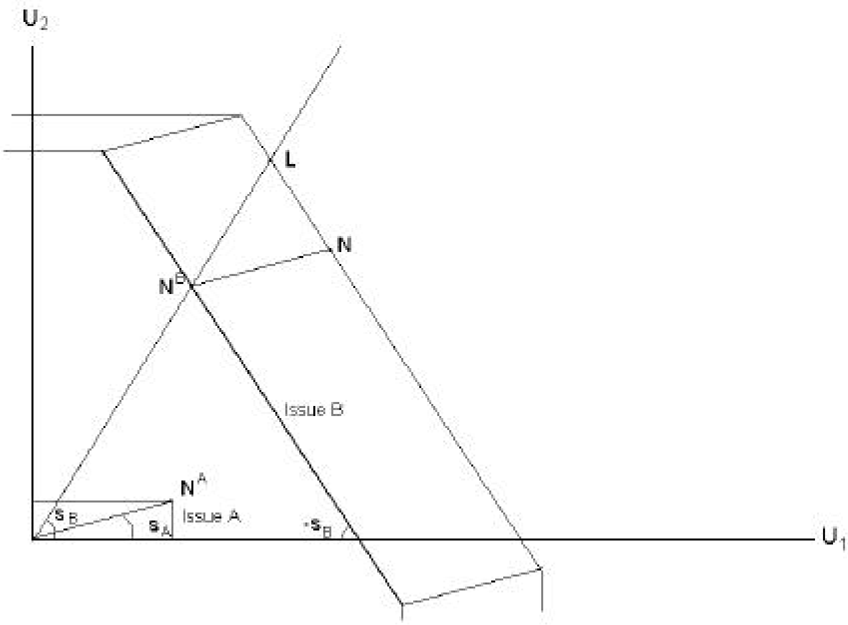

Figure 6: *1 loses and 2 benefits from linking*

However, if a favor F^B to 2 is not possible either, then it trivially follows:

Corollary 2: *Suppose that Assumptions 1-4 hold. If* $F^A = F^B = 0$, *L=N and nobody benefits or loses from linking.*

In Figure 6, the frontier of issue A is extremely convex: it only consists of one point. Another extreme case exists if the frontiers are weakly convex (linear) in the entire first quadrant. If the bargaining problems are about how to split two different cakes, for example, the following assumption is likely to hold:

Assumption 5: *Let* $A_2^1 = B_1^2 = 0$.

This implies that the corner of issue *A* preferred by 1 (to keep the entire cake *A*) is on the x-axis, and gives 2 zero utility. Similarly, the corner of issue *B* preferred by 2 is on the y-axis, and gives 1 zero utility. Then[2]:

Corollary 3: *Suppose that Assumptions 1-5 hold, and that the frontiers of A and B intersect. Then, 1 and 2 both gain from linking.*

Proof: Under Assumption 5, $F_1^A = N_1^A$ so that 1 cannot loose from linking according to Lemma 3. Moreover, $N_1^A = \frac{1}{2}A_1^1 > N_1^B \Rightarrow A_1^1 > N_1 \Rightarrow C_1 > N_1$ so that 1 prefers *C* to *N*. Then, it follows from Lemma 2 that 1 benefits from linking. A similar argument shows that 2 also benefits from linking. *QED*

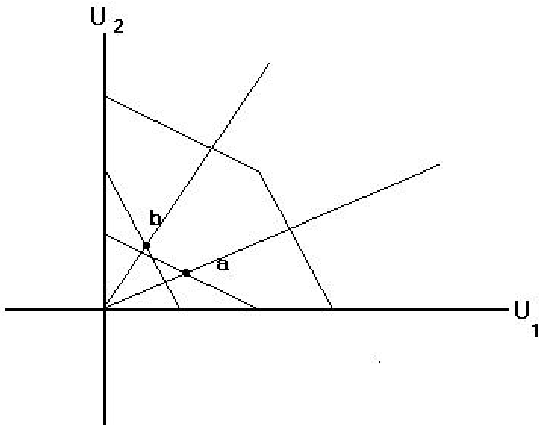

Figure 7: *Both 1 and 2 gain from linking*

If the frontiers of *A* and *B* are instead not crossing, i.e. one frontier lies entirely below the other (both parties prefer the entire cake *A* to the entire cake *B*), then only one party will gain from linking, while the other will be indifferent[3]:

Corollary 4: *Suppose that Assumptions 1-5 hold, and that the frontier of A is entirely above the frontier of B. Then, 1 benefits from and 2 is indifferent to linking.*

Proof: The proof that 1 gains is identical to the previous proof. Moreover, $N_2^B = \frac{1}{2}B_2^2 < N_2^A \Rightarrow B_2^2 < N_2 \Rightarrow C_2 = B_2^2 < N_2$, so that 2 prefers *N* to *C*. Since $B_1^2 = 0$, it follows from Lemma 3 that 2 will neither gain nor lose from linking, and thus, 2 is indifferent to linking. *QED*

[2] This result is also found in Horstmann, Markusen and Robles (2000).
[3] This result is similar to Proposition 2 B in Horstmann, Markusen and Robles (2000).

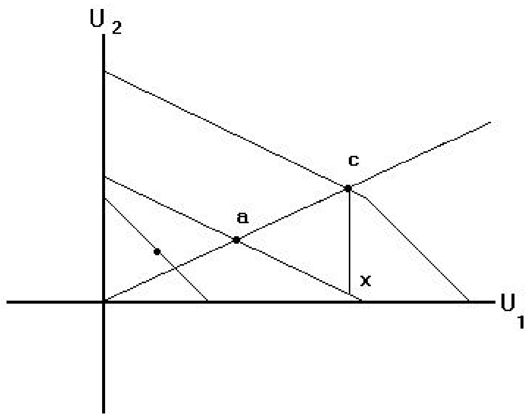

Figure 8: *A case where 1 gains from linking while 2 is indifferent*

3.6. Comparative Static

Before relaxing more assumptions, let us study the effect of a change in the utility possibility set for one issue. This is interesting in general because we get an idea of how the shape of the frontiers maps into gains in utilities and, in particular, because changes in the frontier can often be made by adding similar issues to the negotiations. To be specific, we will study the effect of a marginal increase in favor F^A by letting A_1^1 increase while keeping s_A constant, as in Figure 9.

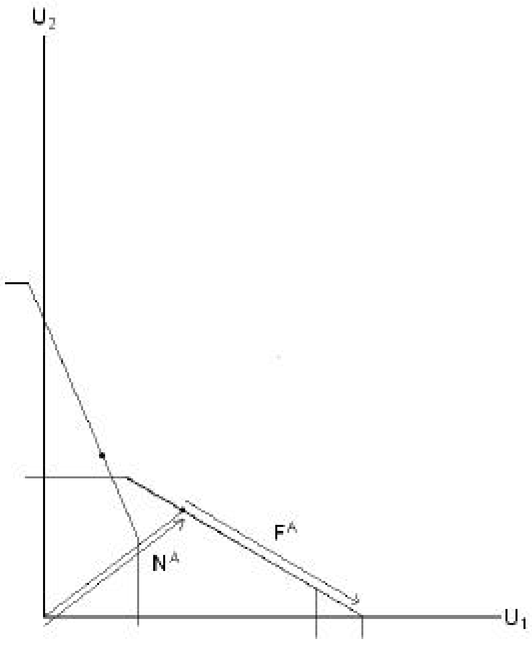

Figure 9: *The meaning of an increase in* F^A

Technically, this might be interpreted as a less curved bargaining frontier. In our example, F^A increases if one includes non-tariff barriers to trade in the negotiations on tariffs for agricultural products.

As illustrated in Figure 10, the following proposition is easy to show:

Proposition 7: *Suppose that Assumptions 1-3 hold, and suppose that the potential favor F^A increases slightly. If the linked bargaining solution is as in Proposition 5*
a), then 1 benefits and 2 loses;
b), then the equilibrium is unchanged;
c), then both benefit;
d), then the equilibrium is unchanged;
e), then 1 benefits and 2 loses.

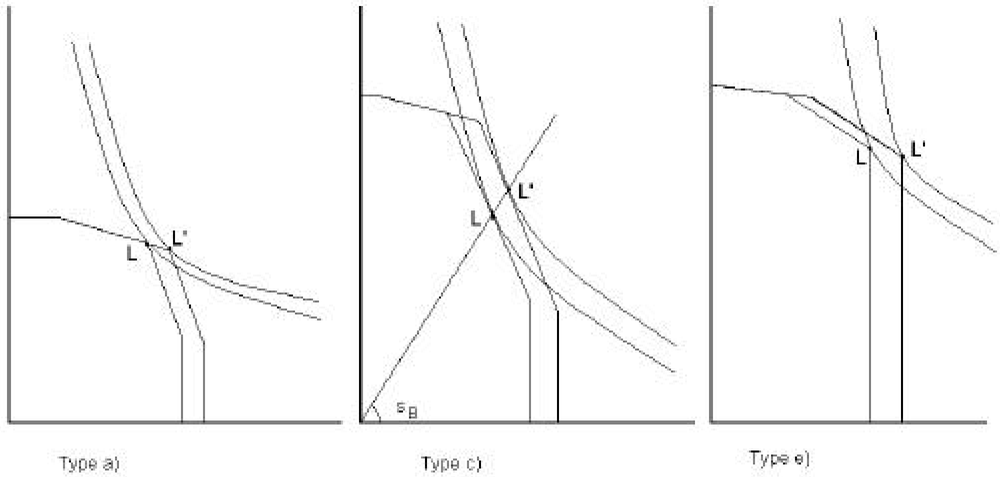

Figure 10: *The equilibrium changes from L to L', 1 benefits and 2 may lose*

1 benefits from a longer potential favor F^A if F^A is already exhausted ($L^A=A^1$), which will be the case if $s_L>s_A$. If issue B is also taken to a corner (equilibrium type a or e), then a longer F^A means a larger favor from 2 to 1, and 2 loses because there is no increased reciprocal favor from 1 to 2. If, however, B is not taken to the extreme (equilibrium type c), a longer F^A implies that more favors can be mutually exchanged and 2 also benefits. If issue A is not taken to the extreme (because $s_L<s_A$ as in b) or d)), then a longer F^A obviously changes nothing.

4. Extensions

The above analysis relied on restrictive assumptions. Here, we discuss how these may be relaxed. Let us first discuss Assumption 2, then Assumption 1, before finally discussing how to relax Assumption 3.

4.1. Linking Arbitrary Issues

It is difficult to study the question of who gains and who loses from linking if arbitrarily shaped frontiers are allowed. Under the assumption that the Pareto frontier is linear, however, we were able to find some intuitively appealing results. But would these results survive if Assumption 2 were relaxed?

Suppose instead that the Pareto frontiers are differentiable everywhere. According to Proposition 2, there exist gains from exchanging favors as long as the slopes of the two frontiers are different. Under Assumptions 1-4, F^A is the south-east pointing vector along the Pareto frontier of *A*, such that the slope of the frontier along this vector is everywhere $-s_A = -s_{NA}$. For a differentiable frontier, F^A is an approximation as shown in Figure 11. As found in Proposition 6, 1 will gain from linking if this favor F^A to 1 is large compared to either N^A or F^B. As long as the linear vectors F^A and F^B are good approximations of the frontiers of *A* and *B*, this basic intuition is likely to hold.

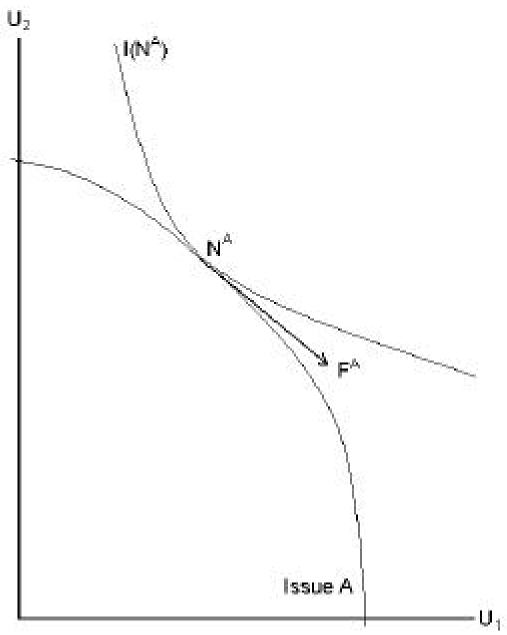

Figure 11: *F^A is an approximation*

If the bargaining sets are strictly convex and differentiable, L^A and L^B will be located such that the slope of the frontiers at these points are equal, and equal to the slope s_L.

The benefit for 1 of linking is therefore $L_1^A - N_1^A$, while the loss is $L_1^B - N_1^B$. If the frontier of A is not very curved to the right of N^A, such that F^A is large, the benefit $L_1^A - N_1^A$ is likely to be large. If the frontier of *B* is not very curved to the left of N^B, the loss $L_1^B - N_1^B$ is likely to be large. Moreover, such favors will be given most extensively to the party that benefits the least from *N* relative to the slopes of these favors.

4.2. How to Link?

The above analysis relied on the Nash bargaining solution. However, from the non-cooperative bargaining theory, we know that the bargaining outcome depends on institutional details such as who offers to whom; who can reject; and who will then provide an offer next time. There exist several bargaining procedures which imply the Nash bargaining solution (in limit); see for example Nash (1953), Binmore, Rubinstein and Wolinsky (1986), Binmore (1987) or Rubinstein, Safra and Thomson (1992). This paper relies on the Nash bargaining solution for simplicity and for its nice features, but if we want to apply the theory to specific bargaining situations not covered by the papers above, one might want to pay attention to institutional details and set up a non-cooperative bargaining game.

The paper also relied on Definition 4 and was not concerned with how linking actually takes place. One way of linking issues is to let each offer be a pair of outcomes, one for issue *A*, the other for issue *B*. Another way of linking issues is sequential bargaining, which is here defined as a bargaining method with the following timing: First *A* is negotiated and preliminary agreed upon. Second, *B* is negotiated and preliminary agreed upon. If and only if there is an agreement for each issue, both agreements are finally agreed upon as they stand. If the parties fail to reach an agreement on one issue, they will not agree on the other issue either. Thus, the agreement in *A* is made conditional on a (not yet specified) agreement in *B* to be reached. This was the procedure in the Uruguay round. But will such sequential bargaining imply that the issues are linked as in Definition 4?

Suppose that the Pareto frontiers of projects *A* and *B* are defined by *a(x)* and *b(z)*, and suppose that the first stage gave the preliminary solution *x*. Thus, in addition to the gains from project *B*, agents 1 and 2 get *x* and *a(x)* if they agree upon *B*. The Nash bargaining solution of the second stage is then given by:

$$\underset{z}{Max}\, U_1 U_2 = \underset{z}{Max}(x+z)(a(x)+b(z))$$

where *x* is given from the previous stage. This gives a solution z as a function *z(x)*. In the first stage, the parties anticipate that if reaching an agreement, they will agree on *(z(x),b(z(x)))* in the next stage. Thus, this is the expected additional gain to be taken into account if they agree on issue *A* in the first stage. Therefore, the Nash bargaining solution in the first stage is found by:

$$\underset{x}{Max}(x+z(x))(a(x)+b(z(x)))$$

It is easy to check that the two first-order conditions for maximizing the Nash-product in the first and second period are identical to the first-order conditions from the linked problem:

$$\underset{x,z}{Max}(x+z)(a(x)+b(z))$$

Proposition 8: *Issues A and B are linked in sequential bargaining.*

Thus, sequential bargaining captures all the gain from linking issues, and the order in which the issues are negotiated is of no importance. The same result holds if there are more than two issues. If the project *A* most favorable to 1 is first negotiated upon, 2 will offer 1 a great deal. In the next stage, 1 has more to lose if negotiations break down (since 1 then loses the gain from the first stage). This gives 2 more bargaining power, and 2 will capture more of *B* than she otherwise could. As shown, this substitution between utility in one project for less bargaining power in the other captures all the gains from linking issues, when the Nash bargaining solution is the relevant one.

There are, however, several circumstances that may break this nice proposition. Such circumstances are here ruled out since we focus on the Nash bargaining solution, and do not take bargaining frictions or bargaining costs into account. A more non-cooperative game theoretic model could do this. Fershtman (1990) studies a sequential alternating-offer bargaining-game of the kind introduced by Rubinstein (1982). Fershtman also assumes that the outcome is implemented once both issues are agreed upon. He shows that each party prefers to first bargain over the issue that is of relative least important to itself. The reason is that, if the other party has a large gain from the first stage, it will be more impatient in the second round of bargaining, and the first party will then be able to extract a large share of the issue which is most important to her. Fershtman also shows that the allocation in equilibrium will not necessarily be efficient. As the bargaining friction, or the discount rate, approaches zero, however, the order of the sequential bargaining does not matter, and the allocation will be as if the issues are negotiated upon simultaneously. Thus, he reaches a result similar to Proposition 8.

Busch and Horstmann (1997) also compare simultaneous and sequential bargaining. In contrast to Fershtman (1990), they assume that each issue is implemented as agreed upon. A party will then prefer to first negotiate on the issue of largest importance relative to the other party. Busch and Horstmann (1997) also study the effect of fixed bargaining costs, and find that the order of the sequential bargaining still matters, even if the discount rate is zero. The results for this case are more mixed, however. While Busch and Horstmann (1997) focus on the conditions for when the agenda matters, in a related paper Herrero (1989) focuses on the conditions where the outcome will be independent of the agenda.

4.3. Complementary Issues

The analysis above relied on the crucial Assumption 3, i.e. that the issues are independent. However, an important reason why there exist gains from linkages is that issues may be complementary, i.e. the gain from one issue (e.g. trade in technical equipment) depends on the agreement on another issue (e.g. the extent of technical standards).

The gains implied by the complementarity of issues will complement, and not substitute, the gains from linking issues studied in this paper. Therefore, to study the linking of independent issues seems like a natural first step and a building block for studying linked complementary issues. However, if there are further gains from linking issues than those studied here, a party is less likely to lose from linking than the results in this paper suggest.

The most interesting question related to linking bargaining issues might be to ask which issues are complementary and which are not, and what the consequences are for the optimal and the equilibrium negotiation agenda. For example, the interaction and complementarity of agreements on international trade and specific agreements on political cooperation provide an interesting case for future research.

5. Conclusions

As noted, the literature on linking different issues in international negotiations is still very small. This is surprising, since the political and public debate concerning what and how to link issues is considerable.

This paper contributes to the questions of linking issues. We first noticed that, in general, there are potential gains from linking issues, and that such linkages will always be made if there is a pre-stage where the parties are bargaining over whether the issues should be linked. Nevertheless, it is important to study who will gain and who will lose from such linkages. The results show that a party is likely to gain from linking issues if the potential favor to her from the issue of most importance to her is large relative to the issue itself or relative to the potential favor to the other party, and if simultaneously, she does not benefit a great deal relative to the other party. The results are helpful in understanding different countries' preferences for linkages, and how these can be modified.

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