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## **BARGAINING FOR OPEN SKIES**

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### **ABSTRACT**

In this paper we analyze the bargaining problem between countries when negotiating bilateral air service agreements. To do so, we use the methods of bargaining and game theory. We give special attention to the case where a liberal minded country is trying to convince a less liberal country to agree to bilateral open skies, and the liberal country might also unilaterally open up its market. The following analysis is positive in the sense that the results help explain and predict the outcome of negotiations under different payoffs and structures of the bargaining process. They are normative in the sense that adequate manipulation of the bargaining conditions can ensure a desired outcome.

### **INTRODUCTION**

The purpose of this paper is to systematically analyze the bargaining problem between countries when negotiating bilateral air service agreements. We will give special attention to the case where a liberal minded country is trying to convince a less liberal country to agree to bilateral open skies, and the liberal country might also unilaterally open up its market. The following analysis is positive in the sense that the results help explain and predict the outcome of negotiations under different payoffs and structures of the bargaining process. They are normative in the sense that adequate manipulation of the bargaining conditions can ensure a desired outcome.

The basis for all air service agreements is the Chicago Convention, which entered into force on 4 April 1947. It establishes the principle that each state has complete and exclusive sovereignty over the airspace above its territory. Thus all international air transport is subject to authorization, which is accomplished through a system of some 3000 bilateral (and very few regional) agreements. The classic bilateral air service agreement of the

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Bermuda 1 type includes detailed provisions for market access, capacity and tariffs.

Although recent air service agreements tend to be more liberal in some or all of these aspects (see for example World Trade Organization, 1998, and Morrell, 1998), many still fail to completely deregulate markets. Recognizing that further deregulation provides scope for more trade in airline services and thus more gains in trade, some countries have been pushing towards bilateral open skies agreements. For example, the U.S. has signed open skies air service agreements with 42 countries and is pressing further (Oum, 2000).

Other countries may adopt a less liberal attitude towards air services. First, for some reason a country may take the position that further deregulation does not enhance national welfare (Forsyth, 2000). Second, even if total national welfare is enhanced, distributional effects might be undesirable. Third, even if redistribution is socially acceptable, it might come at the expense of special interest groups. These organized few (i.e., airlines, airports, labor unions) may secure rents from the government at the expense of the unorganized many (i.e., consumers) by lobbying against deregulation.<sup>1</sup> Fourth, a country might speculate that hiding its true (liberal) preferences will provide an opportunity to free ride on the deregulation of foreign markets while keeping the domestic market shut. Considering this, it is not too surprising that negotiations towards more liberal bilateral air service agreements are in many cases stagnant.<sup>2</sup>

Another option for a liberal country (*A*) then is the unilateral opening of its home market to a less liberal country (*B*). For example the Australian government has decided to offer foreign international airlines unrestricted access to all of Australia's international airports except Sydney, Melbourne, Brisbane, and Perth (Australia's Commonwealth Department of Transport and Regional Services, 1999). The Canadian Transport Minister in response to the domestic dominance of Air Canada/Canadian Airlines announced that "if over a period of 18 months, a couple of years, competition doesn't come forward, then we'll invite foreign carriers in" (Air Transport World, June 2000, p. 9).

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<sup>1</sup>For example, on February 10, 2000, the CAPA, an association of U.S. airline pilot unions, addressed the U.S. Department of Transportation in an open letter, stating that they were unalterably opposed to the exchange of cabotage rights.

<sup>2</sup>The following examples provide some anecdotal evidence. In 1998 and 1999 Germany approached 10 countries where prospects for bilateral open skies seemed promising. By February 2000, negotiations hit a deadlock in all but one case. David Marchkick, the chief United States negotiator in aviation rights talks with the United Kingdom, recently resigned as an expression of his frustration of the slow pace of talks over open skies (London Financial Times, October 9, 1999).

But a unilateral opening may imply that country *A* further discourages country *B* to accept a liberal bilateral agreement, as the reward from such an agreement, the opening of *A*'s market, already pertains to *B*: the “carrot” has been fed to *B* in form of a unilateral opening and *A*'s feed bag is empty.

In the next section, we formalize these notions into different bargaining processes and present equilibrium results that depend on countries' preferences, information sets and the structure of bargaining. Policy implications and further conclusions follow in the final section.

### THE MODEL

Consider the bargaining problem between a liberal country *A* and a less liberal country *B*.<sup>3</sup> Air traffic between *A* and *B* is regulated by a restrictive air service agreement. Denote the payoff to *A* (*B*) under agreement *i* by  $\alpha_i$  ( $\beta_i$ ). If *A* and *B* do not negotiate or if they fail to reach an agreement, we normalize payoffs to  $(\alpha_0, \beta_0) = (0, 0)$  per period, representing the status quo or the threat point.

Country *A* may decide to unilaterally open up its market (*A* and *B* “agree” on “1”), resulting in total discounted payoffs of  $(\alpha_1, \beta_1)$  at the time of market opening. Unilateral opening might encompass full market access for *B* to, from, and beyond country *A*, cabotage within *A*, etc. whereas country *A*'s traffic rights with *B* remain restricted. Countries *A* and *B* may also agree on “2”, bilateral open skies (or at least a higher degree of deregulation than under the existing agreement), resulting in discounted payoffs of  $(\alpha_2, \beta_2)$  at the time of agreement.

Note that payoffs are the additional rents that deregulation provides and  $\beta_2$  is the carrot. We will restrict analysis to these three distinct cases although one might argue that actual bargaining might also cover other degrees of deregulation.

Both *A* and *B* are fully rational in the sense that they bargain to maximize expected payoffs, any bounded rationality, problems of special interest groups, etc., then are captured in the payoffs. We will assume that both unilateral and bilateral deregulation improve total welfare of the two countries:<sup>4</sup>

$$\alpha_2 + \beta_2 \geq 0 \text{ and } \alpha_1 + \beta_1 \geq 0. \quad (1)$$

<sup>3</sup>The analysis does not change if *A* is a deregulated region that has given a mandate to negotiate on behalf of the whole region.

<sup>4</sup>From the general theorem of the second best it follows that a small departure from the first best (unilateral open skies) need not be better than a large one (bilateral regulation). Thus it need not be the case that  $\alpha_2 + \beta_2 \geq \alpha_1 + \beta_1$ .

By assumption  $A$  is liberal which implies  $\alpha_2 \geq 0$ ,  $\alpha_1$ .<sup>5</sup> Hence payoffs for  $A$  can take two forms:

$A^w$ :  $\alpha_2 > \alpha_1 > 0$ , in this case we will say that  $A$  is **weak** (for reasons that will later become apparent). Denote a weak  $A$  by  $A^w$ .

$A^s$ :  $\alpha_2 > 0 > \alpha_1$ , in this case we will say that  $A$  is **strong**, denoted by  $A^s$ .

The strict inequalities rule out indifference between the alternatives and thus simplify the following arguments.

If country  $B$  values bilateral deregulation higher than both unilateral opening on behalf of  $A$  and the status quo ( $\beta_2 > \beta_1, 0$ ) then  $A$  and  $B$  have common interests and will agree on bilateral open skies. Furthermore,  $\beta_1 < 0$  cannot be part of  $B$ 's payoff because unilateral open skies give  $B$  all opportunities it has under the status quo, plus some more. Thus we are left with two different possible payoff structures for  $B$ :

$B^w$ :  $\beta_1 > \beta_2 > 0$ , in this case we will say that  $B$  is **weak**. Denote a weak  $B$  by  $B^w$ .

$B^s$ :  $\beta_1 > 0 > \beta_2$ , in this case we will say that  $B$  is **strong**, denoted by  $B^s$ . Country  $B$  is strong if the carrot is small.

In all models, countries  $A$  and  $B$  cannot make binding agreements or commitments apart from those explicitly mentioned ("1" and "2", so far). In particular, they cannot agree on side payments, that is they cannot arrange payoffs  $(\alpha_i - \Delta, \beta_i + \Delta)$ , and they cannot (credibly) ex ante commit to make unilateral restrictions that are not rational ex post.

In what follows, we will analyze various sequential structures of bargaining between different types of  $A$  and  $B$  by applying the according equilibrium concepts. We employ a strategic approach, which embodies a detailed description of the bargaining procedure, because it is especially suitable to model and analyze negotiations between governments or states on an international level (Holler and Illing, 1990, p. 241).

In contrast to the strategic approach, the axiomatic approach relies on desirable properties that the outcome of a bargaining problem should comply with. Due to the leeway involved in defining desirable properties, there are numerous axiomatic solution concepts. In the case of two possible agreements, two axioms (Selten's axioms) suffice to establish the most commonly applied Nash solution (Harsanyi, 1987):

1. Monotonicity. Starting with a symmetrical game ( $\alpha_1 = \beta_2$  and  $\alpha_2 = \beta_1$ ) and increasing one or both payoffs of an agreement will make this agreement the solution of the new game.

<sup>5</sup>Any other preference ordering would be trivial, anyway:  $\alpha_1 \geq 0$ ,  $\alpha_2$  implies that  $A$  opens unilaterally and  $0 \geq \alpha_1$ ,  $\alpha_2$  implies that  $A$  realizes the threat point.

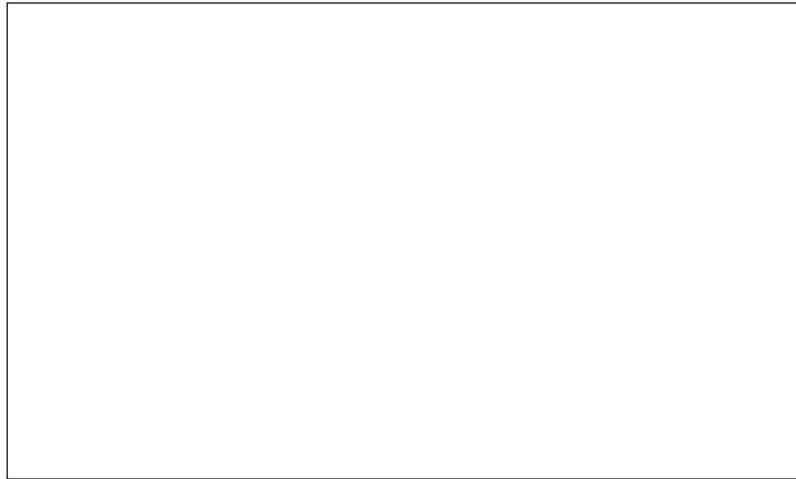
2. Linear Invariance. The outcome will not change under an order-preserving linear transformation of utilities.

Assume that both countries are weak. Then under monotonicity and linear invariance, the solution to our bargaining problem is unilateral opening of  $A^w$  if  $\alpha_1\beta_1 > \alpha_2\beta_2$  holds, and bilateral open skies if  $\alpha_2\beta_2 > \alpha_1\beta_1$  holds. In the following sections, we will apply the strategic approach.

### Bargaining with Complete Information and a Finite Horizon

#### *One-shot Bargaining*

Denote a bargaining process over  $T$  periods between parties  $i$  and  $j$  where  $i$  moves first in period  $T$  (the last period) by  $\Gamma_T(i, j)$ . Now consider  $\Gamma_1(B, A)$ , the case of a one-shot bargaining process where first  $B$  makes an offer and then  $A$  either accepts or rejects.<sup>6</sup> Every aspect of the bargaining process is common knowledge, that is  $A$  and  $B$  know the structure of the bargaining process and each others payoffs, and they know that they know, and so on.



**Figure 1: One-shot Bargaining Process  $\Gamma_1(B, A)$ .**

Figure 1 depicts the extensive form of  $\Gamma_1(B, A)$  where dominated strategies are eliminated: neither  $B^w$  nor  $B^s$  ever offer “0” because both can secure at least those payoffs by offering “1”, and neither  $A^w$  nor  $A^s$  ever reject offer “2”. By backward induction we obtain the subgame-perfect

<sup>6</sup> $B$  offering unilateral opening of country  $A$  may be interpreted as  $B$  not offering anything.

equilibria, that is the Nash equilibria that do not involve noncredible threats. The payoffs of  $\Gamma_1(B, A)$  then are as in Table 1 (the according strategies are straightforward).

**Table 1: Payoffs of  $\Gamma_1(B, A)$**

	$A^s$	$A^w$
$B^s$	(0, 0)	$(\alpha_1, \beta_1)$
$B^w$	$(\alpha_2, \beta_2)$	$(\alpha_1, \beta_1)$

If country  $A$  is of type  $A^w$ , the result of the bargaining process will always be unilateral opening of  $A^w$  because  $A^w$  cannot credibly threaten not to open unilaterally if  $B$  offers “1”, and  $B$  knows this. This absence of a credible threat ( $\alpha_1 > 0$ ) makes  $A^w$  weak.

If  $A$  is strong it credibly threatens not to open up if offered “1” ( $0 > \alpha_1$ ) and then equilibrium depends on the type of  $B$ :  $B^w$  will offer “2”, because bilateral opening offers a higher reward than the status quo ( $\beta_2 > 0$ ) and  $A^s$  will accept. In contrast,  $B^s$  will not offer “2” ( $0 > \beta_2$ ) and  $A^s$  will not open up its market when offered “1”. Both realize their threat point because it is individually rational not to agree to the unfavorable agreement. In this case neither country is at its bliss point, and even in the absence of side payments there is room for improvement on both sides.

**Proposition 1 (Pareto-improving Lottery).** If both countries are strong and risk neutral and any deregulation improves total welfare, then there exists a Pareto-improving lottery.

**Proof.** Let  $L$  denote a lottery where unilateral open skies are drawn with probability  $p$  and bilateral open skies with probability  $(1 - p)$ . If  $A^s$  is risk neutral, it will accept  $L$  if and only if  $p\alpha_1 + (1 - p)\alpha_2 \geq 0$  or, rearranging,

$$p \leq \frac{\alpha_2}{\alpha_2 - \alpha_1} \equiv p_A, \text{ where } 0 < p_A < 1. \quad (2)$$

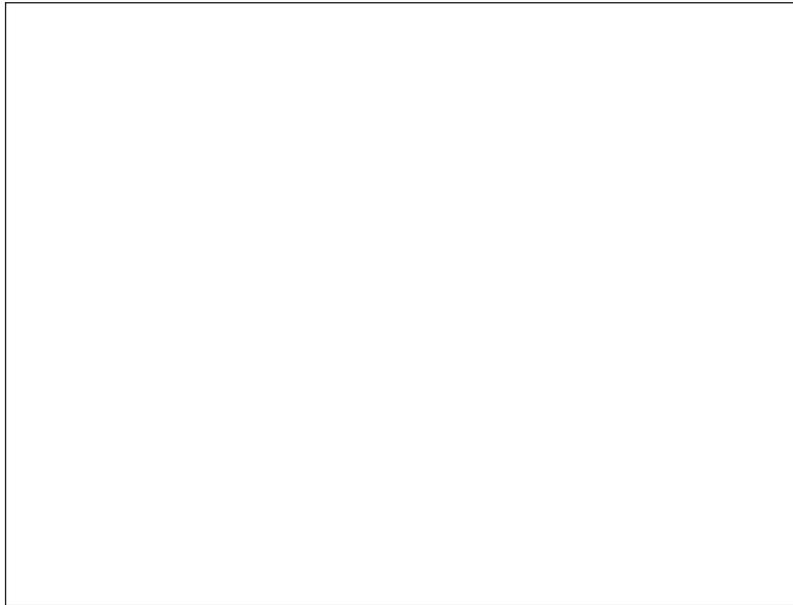
Risk neutral  $B^s$  will offer  $L$  if and only if  $p\beta_1 + (1 - p)\beta_2 \geq 0$  or, rearranging,

$$p \geq \frac{\beta_2}{\beta_2 - \beta_1} \equiv p_B, \text{ where } 0 < p_B < 1. \quad (3)$$

Lottery  $L$  will be offered and accepted if and only if  $p_B \leq p \leq p_A$ . Now assume that no such lottery exists which implies  $p_B > p_A$ . Applying Equation 2 and Equation 3 and rearranging yields

$$\alpha_1\beta_2 > \alpha_2\beta_1. \quad (4)$$

Deregulation improves welfare:  $\alpha_2 + \beta_2 \geq 0$  and  $\alpha_1 + \beta_1 \geq 0$ . This can be rearranged to  $\alpha_2 \geq -\beta_2$  and  $\beta_1 \geq -\alpha_1$ , and combining the two yields  $\alpha_2\beta_1 \geq \alpha_1\beta_2$ , contradicting (4) and thus the assumption. ■



**Figure 2: Payoffs With and Without Lottery.**

Figure 2 illustrates Proposition 1. If  $A^s$  and  $B^s$  could enter a binding agreement to conduct a lottery  $L$  with  $p_B \leq p \leq p_A$ , both could secure a higher expected payoff because the lottery convexifies the payoff possibilities. This lottery may for example come in the form of third party arbitration where the probabilities of ruling in favor of any outcome are as described above.<sup>7</sup>

Now consider  $\Gamma_1(A, B)$ , that is  $A$  makes an offer and  $B$  accepts or rejects. The equilibrium payoffs of  $\Gamma_1(A, B)$  are identical with those of  $\Gamma_1(B, A)$

<sup>7</sup>Note that at this point we are introducing further possibilities of binding agreements, changing the nature of the bargaining process from noncooperative to cooperative.

except if both players are weak, where  $\Gamma_1(A, B)$  results in bilateral open skies (see Table 2).

**Table 2: Payoffs of  $\Gamma_1(A, B)$**

	$A^s$	$A^w$
$B^s$	(0, 0)	$(\alpha_1, \beta_1)$
$B^w$	$(\alpha_2, \beta_2)$	$(\alpha_2, \beta_2)$

The reason is that if both countries are weak, any agreement (“1” or “2”) makes both parties better off than no agreement (“0”), and the first mover in the only and thus last round of bargaining chooses the agreement serving him best. Hence the country preparing the last offer has bargaining leverage because it can credibly commit.

### Repeated Bargaining

#### *Repeated Bargaining with a Single Country*

Now consider the case of  $T > 1$  rounds of bargaining between  $A$  and  $B$ , and suppose that countries discount future payoffs by a factor of  $\rho \in (0, 1)$  per period. If an agreement is reached, bargaining is stopped and each player gets the according payoff. Again, every aspect of the bargaining protocol is common knowledge, including the maximum number of bargaining rounds  $T$  and who moves first in each period.

**Proposition 2.** If countries do not discount future payoffs, then only the last round of bargaining determines equilibrium. Formally,  $\Gamma_T(i, j)$  has the same equilibrium payoffs as  $\Gamma_1(i, j)$ .

**Proof.** Suppose  $A^w$  and  $B^w$  are bargaining and  $B^w$  prepares the offer in period  $T$ ,  $A^w$  then either accepts or rejects. As  $T$  is the last period, the parties face a one-shot situation as in Figure 1. Thus  $B^w$  will offer “1” and  $A^w$  will accept, resulting in payoffs of  $(\alpha_1, \beta_1)$ , see Table 1.

First suppose that  $A^w$  is entitled to make an offer in period  $T-1$ .  $B^w$  will only accept offers “ $i$ ” that yield a payoff of  $\beta_i \geq \beta_1$ , otherwise  $B$  would wait another period and realize profits  $\beta_1$  in period  $T$ . Hence  $B^w$  would reject offer “2” and  $A^w$  will offer “1”, which  $B^w$  accepts.

Next suppose that  $B^w$  is entitled to make an offer in period  $T-1$ .  $A^w$  accepts any offer “ $i$ ” resulting in a payoff of  $\alpha_i \geq \alpha_1$ , otherwise it would

prefer to wait until period  $T$  and realize  $\alpha_1$ . But here  $B^w$  will realize its bliss point by offering “1”, which  $A^w$  accepts.

So no matter who makes an offer in period  $T-1$ , the bargaining will result in payoffs  $(\alpha_1, \beta_1)$ . Now we may repeat the same argument for period  $T-2$ , and so forth up to period 1. Whoever makes an offer in the first period will offer “1” and the other country will accept.

All other cases can be shown in a similar manner. ■

The intuition behind Proposition 2 is as follows: if up to period  $T-1$  no agreement has been reached, the resulting bargaining situation is as in the one-shot setting. As time is not costly, any side can credibly threaten to wait for the last round to secure the payoffs of the one-shot bargaining game, thus no other outcome can be an equilibrium. Actual agreement may be reached in any round of bargaining. The equilibrium is invariant with respect to the order in which offers are made up to and including round  $T-1$ . Hence the country preparing the offer in round  $T$  has the full bargaining power.

Now we are concerned with the equilibria if countries do discount future payoffs.

**Proposition 3.** If at least one country is strong, then Proposition 2 also holds if countries discount future payoffs ( $\rho < 1$ )

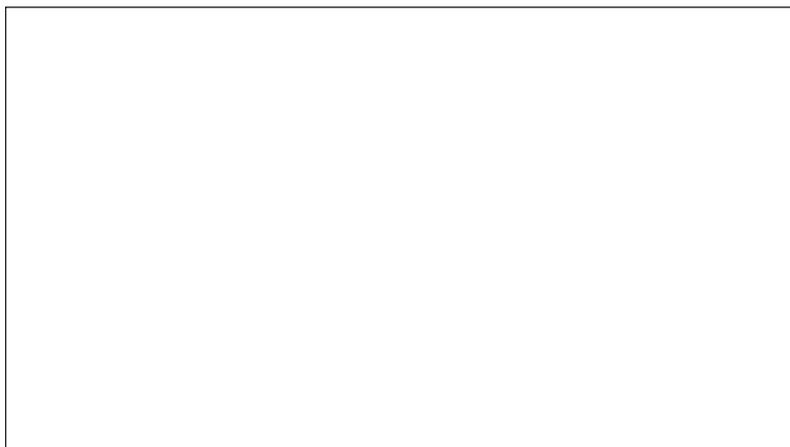
**Proof.** Consider  $\Gamma_T(A^s, B^w)$  and  $\Gamma_T(B^w, A^s)$ . In round  $T$ , parties will agree on “2”, no matter who moves first (see Tables 1 and 2). Now assume that  $A^s$  moves first in round  $T-1$ :  $B^w$  will accept any offer “ $i$ ” that provides payoff  $\beta_i \geq \rho\beta_2$ , therefore  $A^s$  will offer “2” and  $B^w$  will accept. If  $B^w$  moves first in period  $T-1$ ,  $A^s$  will accept any offer “ $i$ ” with  $\alpha_i \geq \rho\alpha_2$ . Because of  $\rho > 0$  and  $\alpha_2 > 0$  this implies  $\alpha_i > 0$ . As  $\alpha_1 < 0$  holds for  $A^s$ , offer “1” will be rejected. Because  $B$  is weak,  $\beta_2 > \beta_0$  holds and  $B$  will offer “2”. So in  $T-1$ , parties will agree on “2”, no matter who moves first. This argument can be repeated for  $T-2$  and so forth up to period 1.

All other cases can be shown in a similar manner. ■

Proposition 3 indicates that if a strong and a weak country bargain, the strong country will always be able to enforce its first best outcome, because the alternative agreement is worse than the status quo. Consequently, two strong countries will always realize the threat point. Delay is costly and hence if parties agree, they will do so in the first round and bargaining is terminated immediately, “...from an economic point of view, the bargaining process is efficient (no resources are lost in delay)” (Osborne and Rubinstein, 1990, p. 50).

**Proposition 4.** If both countries are weak, then the equilibrium depends on the structure of bargaining in the first and in the last round and on the relative sizes of payoffs.

The resulting equilibria under all possible bargaining situations are summarized in Figure 3 (not to be confused with an extensive form game). If both countries are weak, discounting may change the equilibrium outcome. If the discounted first best is worse than the second best, then a party will agree to a proposal of the second best, even if it could secure the first best in the next round.



**Figure 3: Equilibria of  $\Gamma_T(A^w, B^w)$  and  $\Gamma_T(B^w, A^w)$ .**

Here too, equilibrium is always reached in the first round. The equilibria depend on the relative sizes of the payoffs, the discount factor, and which country prepares the offer in the last and in the first round, although the first round only matters if both countries do not care too much about getting the second best instead of the first best.

To clarify the workings behind Proposition 4, we will present the induction process for the case where  $A^w$  offers in  $T$ ,  $\alpha_1 > \rho\alpha_2$  and  $\beta_2 < \rho\beta_1$ , which results in unilateral open skies (“1”).

In period  $T$ ,  $A^w$  offers “2” and  $B^w$  accepts. First assume that  $A^w$  offers in  $T-1$ . Country  $B^w$  accepts any offer “ $i$ ” where  $\beta_i \geq \rho\beta_2$ . Hence  $A^w$  will offer “2” and  $B^w$  will accept. This argument can be repeated leading to equilibrium “2” if  $A^w$  always offers (displayed as a separate branch in Figure 3).

Let period  $T-k$ ,  $1 \leq k < T$ , be the last period where  $B^w$  offers. By the above induction process we know that in period  $T-k+1$ ,  $A^w$  offers “2” and  $B$  accepts. So in period  $T-k$ ,  $A^w$  will accept any offer “ $i$ ” such that  $\alpha_i \geq \rho\alpha_2$ . By assumption,  $\alpha_1 > \rho\alpha_2$  and hence  $B^w$  will offer “1” and  $A^w$  will accept.

Turn to period  $T - k - 1$ .  $A^w$  will accept any offer “ $i$ ” where  $\alpha_i \geq \rho\alpha_1$ . So should  $B^w$  offer in  $T - k - 1$  then it will offer “1” and  $A^w$  will accept. On the other hand,  $B^w$  would accept any offer such that  $\beta_i \geq \rho\beta_1$ . But, by assumption,  $\beta_2 < \rho\beta_1$  and thus  $B^w$  would reject “2”. Then  $A^w$  offers “1” and  $B^w$  accepts. This argument can be repeated for all periods  $T - k - 2$  to 1, and the equilibrium agreement is “1”. So to change the equilibrium from “2” (in the case where  $A^w$  prepares all offers) to “1”, it is sufficient that  $B^w$  has the chance to make a single offer in any period, given  $\alpha_1 > \rho\alpha_2$  and  $\beta_2 < \rho\beta_1$ .

The bargaining situation  $\Gamma_T$  is akin to Selten’s chain-store game (Selten, 1978). Take the case where both countries are weak,  $\beta_2 < \rho\beta_1$ , and  $B^w$  moves first in the last period. Country  $A^w$  might be tempted to reject unilateral open skies in the first rounds (or, if  $A^w$  moves first, it might be tempted to offer bilateral open skies) to convince  $B^w$  that it is playing tough and will not accept unilateral opening. But in the last period, there is no reason for  $A^w$  to convince  $B^w$  that it is playing tough anymore, indeed it would be irrational not to open up unilaterally as this would imply a loss of  $\alpha_1 > 0$ . But if the outcome of period  $T$  does not depend on anything that has happened before, why should  $A^w$  bother playing tough in  $T-1$ ? Neither does it generate any immediate payoff nor is it profitable in the future, that is period  $T$ . So  $A^w$  will not play tough in  $T-1$ . This argument can be repeated and the logic of backward induction is incorruptible:  $A^w$  will not play tough and will open unilaterally in the first round; there is no scope for reputation building.

### Bargaining with Different Countries

Now take  $\Gamma_T$  and modify it such that there are  $T$  different less liberal countries  $B_i$ , and country  $A$  engages in a one-shot bargaining process with  $B_i$  in period  $i$ .

The argument for reputation building on behalf of  $A$  then seems even stronger. Consider the case where all countries are weak and  $B_i^w$  moves first in period  $i$ . As  $B_i^w$  is only bargaining once, it cannot recoup the losses it incurs if  $A^w$  rejects offer “1”. So if  $A^w$  has rejected offer “1” for, say,  $k$  periods, then  $B_{k+1}^w$ , who observes this, might be convinced that  $A^w$  will again reject if offered “1”, which in turn would imply that  $B_{k+1}^w$  offers “2”. But this reputation effect does not withstand scrutiny, as the above backward induction argument demonstrates.

Instead, the unique subgame-perfect equilibrium consists of the realization of the one-shot equilibrium in each period. Introducing a slight uncertainty on the side of the  $B_i^w$  about the nature of  $A$  ( $A^w$  or  $A^s$ ) does give room for reputation building, as will become apparent later.

### **Bargaining with an Infinite Horizon**

So far we have assumed that the total number of periods of bargaining is bounded and common knowledge. In this setting, the last period is especially important as it confers bargaining leverage due to the solution concept of backward induction. Because in many practical settings there is no fixed last period of bargaining, it is desirable to overcome this artificiality. Therefore we are now concerned with the results if the countries believe that bargaining will only stop after an agreement has been reached and otherwise continue indeterminately, that is  $T \rightarrow \infty$ . In addition, we will relax the notion of a detailed bargaining protocol, instead each country can make an offer or react to an offer in each period.

Assume that  $\rho \in (0, 1)$ ; time is strictly valuable. If one of the countries is strong and the other is weak, the weak country can at no time expect the other side to agree on the weak country's first best alternative. Hence the best the weak country can achieve is its second best, which is the strong country's first best. Knowing this, the cost of delay lets the weak country offer or agree to its second best in the first period. If both countries are strong, they will never agree because any agreement is to the disadvantage of one side compared to doing nothing.

The more interesting case arises if both countries are weak such that both unilateral and bilateral open skies benefit both parties. Assume that at the beginning of each period, any of the two parties may concede and accept the first choice of the other party. Assume that payoffs are symmetric:  $\alpha_1 = \beta_2 = \pi^0$  and  $\alpha_2 = \beta_1 = \pi^+$ .<sup>8</sup>

If neither of the countries concedes in period  $t$  the bargaining continues in period  $t+1$  and payoffs for period  $t$  are  $(\alpha_0, \beta_0) = (0, 0)$ . If country  $A^w$  concedes in period  $t$  and unilaterally opens its market then bargaining stops and payoffs are  $(\alpha_1, \beta_1) = (\pi^0, \pi^+)$ . Similarly, if country  $B^w$  concedes in period  $t$  and agrees to a liberal bilateral agreement then bargaining stops and payoffs are  $(\alpha_2, \beta_2) = (\pi^+, \pi^0)$ . If both countries concede in the same period then payoffs are  $(0, 0)$ .

This is a discrete-time war of attrition, and the costs of not conceding are the delayed benefits of deregulation. A pure-strategy Nash equilibrium consists of  $A^w$ 's strategy to never concede and of  $B^w$ 's strategy to immediately concede, for another one just swap names.

Of more interest, there is a unique symmetric equilibrium in mixed strategies. Denote by  $p$  the constant probability that one country concedes

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<sup>8</sup>A mixed-strategy Nash equilibrium has the unpleasant property that the equilibrium strategy of a country only depends on the payoffs of the other country and not on its own payoffs. This counterintuitive property is circumvented by equalizing payoffs.

given that the other has not yet conceded. Denote the expected discounted value of a country's payoff if it continues bargaining by  $V_{con}$ . Then with a probability of  $p$  (which is the probability that the other country surrenders) the payoff is large ( $\pi^+$ ) and with a probability of  $1 - p$  (the probability that the other country continues bargaining) the payoff is the discounted expected value of the next period:

$$V_{con} = p\pi^+ + (1 - p)\rho V_{con}. \quad (5)$$

On the other hand, surrendering yields  $\pi^0$ :

$$V_{sur} = \pi^0. \quad (6)$$

In a mixed-strategy equilibrium the payoffs of continuing and surrendering have to be equal, and from Equation 5 and Equation 6 we get

$$p^* = \frac{1 - \rho}{\pi^+ / \pi^0 - \rho}. \quad (7)$$

The strategies of each player to concede with probability  $p^*$  in period  $t$  if the other player has not surrendered before  $t$  then form a subgame-perfect Nash equilibrium (see Fudenberg and Tirole, 1991, p. 120).

Equation 7 reveals some interesting comparative static results of equilibrium behavior. As impatience of the countries grows ( $\rho$  runs from 1 to 0) the probability of surrendering increases ( $p^*$  runs from 0 to  $\pi^0/\pi^+$ ). So if time is not costly, nobody will ever concede. If on the other hand delay is so costly that next period's payoffs are worthless, then countries will concede with probability  $\pi^0/\pi^+ < 1$ .

As the additional benefits from winning grow ( $\pi^+/\pi^0$  runs from 1 to  $+\infty$ ) the probability of surrendering decreases ( $p^*$  runs from 1 to 0). Countries fight longer if the prize is big. The expected bargaining time may be calculated by interpreting  $t$  as time. Then each country surrenders according to a Poisson process with parameter  $p^*$  and the probability of a country still bargaining at time  $t$ , given that the other country still bargains, is  $\exp(-p^*t)$ . As these probabilities are independent as long as bargaining continues, the probability that the bargaining is still in progress at time  $t$  is  $\exp(-2p^*t)$ , which yields expected bargaining time of  $1/(2p^*)$  with variance  $1/(2p^*)^2$ .

Although continuing to bargain does not induce any direct monetary costs on the countries, there are opportunity costs for postponing a mutually favorable agreement. As in equilibrium both continuing and surrendering yield the same expected payoff, it follows that all additional rents above  $\pi^0$  are dissipated by delaying agreement so long until the expected discounted payoff equals  $\pi^0$ . Note that the postponement of an

agreement has no socially valuable by-product, thus dissipation is socially wasteful.

### **Bargaining with Incomplete Information**

So far we have assumed that all aspects of bargaining are common knowledge and deterministic. But incomplete information and/or randomness may come in many modes. Country *A* may not know Country *B*'s payoffs, or vice versa, or both. Countries might be unsure about their own payoffs, especially of those in the distant future. There could be uncertainty about the duration of the bargaining process or about the exact structure of the game. Payoffs might be random, for example they may depend on the mix of business and tourist passengers, which in turn depends on the weather, or payoffs may depend on the outcome of the next election.

Most of these extensions are beyond the scope of this paper, instead we focus on the case of incomplete information which permits reputation building on behalf of *A*. The following analysis is a simple application of results established by the seminal work of Kreps and Wilson (1982) and Milgrom and Roberts (1982) on the building of reputation under incomplete information.

Under complete information, the logic of backward induction precluded the building of a reputation on behalf of *A*, motivating the chainstore-paradox. Now take another look at the bargaining process between country *A* and *T* different weak countries  $B_t^w$ .<sup>9</sup> Countries *A* and  $B_t^w$  engage in a one-shot bargaining process of type  $\Gamma_1(B_t^w, A)$  in period  $t \in \{1, \dots, T\}$ .<sup>10</sup> Countries maximize discounted payoffs.

The main innovation is uncertainty on behalf of the  $B_t^w$  concerning the type of country *A* they are bargaining with: they initially assess the probability  $\delta$  that *A* is strong with payoffs  $\alpha_2^s > 0 > \alpha_1^s$  and probability  $(1 - \delta)$  that *A* is weak with payoffs  $\alpha_2^w > \alpha_1^w > 0$ . Country *A* on the other hand knows its type and also knows that *B* is weak. Denote this game by  $\Gamma_T(B_t^w, A^\delta)$ .

Assume that payoffs are symmetric in the sense that the gains from improving from second best to first best in relation to the gains from improving from the worst to the second best are identical for  $A^s$  and  $A^w$ :

<sup>9</sup>If the countries  $B_t$  are strong there is no need for reputation building on behalf of *A*. Country  $B_t^s$  never offers "2" because it is dominated by offering "1" ( $\beta_2 < 0$ ).

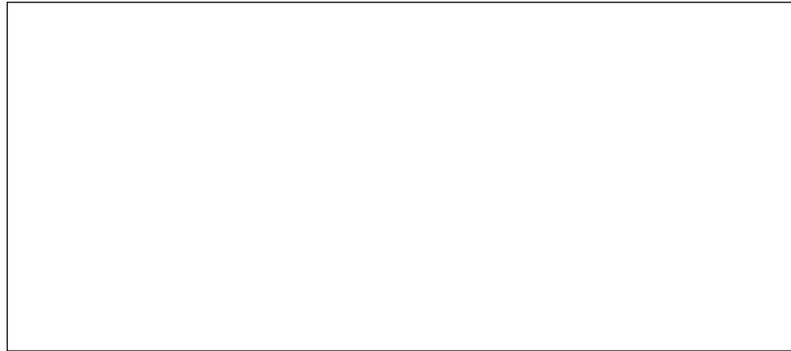
<sup>10</sup>The results do not change if *A* repeatedly bargains with a single country *B*, as long as the agreements are only valid for the period in which they have been made.

$$a \equiv \frac{\alpha_2^w - \alpha_1^w}{\alpha_1^w} = -\frac{\alpha_2^s}{\alpha_1^s}, \quad (8)$$

where  $a > 0$  follows from the assumptions regarding payoffs. Let

$$b \equiv \frac{\beta_1 - \beta_2}{\beta_1}, \quad (9)$$

where a large  $b$  coincides with a small carrot. As  $B$  is weak it holds true that  $0 < b < 1$ . Now a positive affine transformation of payoffs does not change the bargaining game between  $A$  and  $B_t^w$  and yields the bargaining process of a single period as depicted in Figure 4.



**Figure 4. Bargaining Process with One-Sided Uncertainty**

All parties can observe all moves and countries  $B_t^w$  update their belief about  $A$  each period by Bayesian learning. Denote by  $p_t$  the probability assessed by country  $B_t^w$  that  $A$  is strong. Then  $p_t$  is a sufficient statistic for the history of play up to date  $t$ , and choices in period  $t$  only depend on  $p^t$  and for  $A$  on  $B_t^w$ 's offer.

First turn to the case where  $a > 1$ , that is  $A$  gains more from getting the first best instead of the second best than it loses if it gets the worst instead of the second best. Assume further that  $A$  does not discount,  $\rho = 1$ . Then the following beliefs and strategies form a sequential equilibrium of  $\Gamma_T(B_t^w, A^\delta)$  which under some weak conditions is unique (Kreps and Wilson, 1982, p. 264).<sup>11</sup>

<sup>11</sup>A Bayesian equilibrium satisfies the fixed-point condition that strategies are optimal given beliefs and beliefs are obtained from strategies by Bayesian learning. A sequential equilibrium puts further restrictions on the consistency of beliefs off the equilibrium path (see Fudenberg and Tirole, 1991).

**Equilibrium Beliefs**

1. If  $B_{t-1}^w$  offers “2” then  $p_t := p_{t-1}$ .
2. If  $B_{t-1}^w$  offers “1”,  $A$  rejects and  $p_{t-1} > 0$  then  $p_t := \max\{b^{T-t+1}, p_{t-1}\}$ .
3. If  $B_{t-1}^w$  offers “1” and  $A$  accepts or  $p_{t-1} = 0$  then  $p_t := 0$ .

**Equilibrium Strategy of  $A$** 

1.  $A^s$  and  $A^w$  always accept “2”.
2.  $A^s$  always rejects “1”.
3. If  $A^w$  is offered “1” at stage  $t$ , then the response depends on  $t$  and  $p_t$ :
  - (a) If  $t < T$  and  $p_t \geq b^{T-t}$  then reject.
  - (b) If  $t < T$  and  $p_t < b^{T-t}$  then reject with probability  $\frac{(1-b^{T-t})p_t}{(1-p_t)b^{T-t}}$ , accept with complementary probability.
  - (c) If  $t = T$  then accept.

**Equilibrium Strategy of  $B_t^w$** 

1. If  $p_t > b^{T-t+1}$  then offer “2”.
2. If  $p_t < b^{T-t+1}$  then offer “1”.
3. If  $p_t = b^{T-t+1}$  then offer “2” with probability  $1/a$ .

Equilibrium beliefs are formed as follows: if  $A$  is offered bilateral open skies then nothing is learned about  $A$  because both  $A^s$  and  $A^w$  always accept. If  $A$  opens up unilaterally for a single country  $B^w$ , it is established in all following negotiation rounds that  $A$  is weak because a strong  $A$  always rejects offer “1”. If  $A$  rejects unilateral open skies then the probability of  $A$  being strong is adjusted upward. Late rejections of “1” allow for higher probabilities of  $A$  being strong as the benefits of reputation building for  $A^w$  fade towards the end of bargaining.

This in turn explains why it is an equilibrium strategy of  $A^w$  to accept offers “1” towards the end that it would have rejected earlier. Country  $B_t^w$  on the other hand offers bilateral open skies if it assesses a small probability of  $A$  being strong or if there are only few rounds of bargaining left.

Let  $k(\delta) = \sup\{t: \delta < b^{T-t+1}\}$ . For  $t < k(\delta)$ , country  $A$  will never accept unilateral open skies and  $B_t^w$  will offer bilateral opening. In period  $t = k(\delta)$ , there is a non-vanishing probability that a weak  $A$  would accept unilateral opening, but this probability is too small for  $B_t^w$  to offer accordingly. In periods  $t > k(\delta)$ ,  $B_t^w$  may offer “1” and  $A^w$  may accept. It is remarkable that in periods 1 to  $k(\delta)$ , the less liberal countries do not test  $A$  with offer “1” because they know that  $A$  would reject to build its reputation.

If the initial belief that  $A$  is strong is large ( $\delta$  large), then there will be a prolonged period where  $A$  is not tested. The same holds if the carrot is large ( $b$  small). This fact is depicted in Figure 5 for the case where  $A$  bargains with 10 different weak countries. If  $T$  is sufficiently large, even a very small initial assessment that  $A$  is strong leads to bilateral open skies in the first periods.

**Figure 5. Number of Rounds where  $A$  is not Tested in  $\Gamma_{10}(B_t^w, A^\delta)$ .**

### *Extensions*

So far we have assumed that  $a > 1$  and  $\rho = 1$ . The main characteristics of equilibrium do not change for  $0 < a \leq 1$  or for discounting on behalf of  $A$  at a rate of  $\rho > 1/(1 + a)$  or, equivalently,  $\rho > \alpha_1^w / \alpha_2^w$ . Equilibrium behavior may get more complicated towards the end.

If on the other hand  $\rho \leq \alpha_1^w / \alpha_2^w$  holds, then the character of equilibrium does change: country  $A^w$  will accept the first offer “1” and  $B_t^w$  will offer “1”

if  $p_t < b$ , “2” if  $p_t > b$ . Building its reputation by not opening unilaterally then does not pay off for  $A$  because a bilateral agreement in round  $t + 1$  is worth less than a unilateral opening in round  $t$ .

Another possible extension is the introduction of two-sided uncertainty so that neither country is sure about the payoff structure or type of the other side. Kreps and Wilson in their original work do consider two-sided reputation formation, and they find that the resulting game is very similar to a war of attrition game. More recently, Abreu and Gul (2000) consider a model of two-sided incomplete information, two-sided offers, and multiple types, where players bargain over a “pie” of fixed size. The resulting equilibrium has a war of attrition structure and the bargaining outcome is independent of the bargaining protocol.<sup>12</sup> So, as long as both sides have an interest in building reputation and uncertainty is two-sided, the war of attrition seems to be a natural outcome.

### CONCLUSION

In the preceding analysis we have presented different bargaining procedures pertaining to the problem of negotiating bilateral air service agreements and we have deduced the according equilibria. The former analysis is of course by no means complete: we have concentrated on the case of two countries and two possible agreements. Extending the analysis to regional air service agreements and thus multilateral bargaining is easy in the case of Nash’s axiomatic approach, as it extends unchanged to multilateral situations. In the case of the strategic approach, the exact rules and the procedure of bargaining determine the outcome, and equilibria need not be unique.<sup>13</sup> Furthermore, we have ignored any transaction costs associated with bargaining. Despite these shortcomings, we believe that the above analysis provides some guidance for a structured positive analysis.

Now we are concerned with policy implications. Countries may exert influence on the bargaining situation via two levers: payoffs on the one hand and the structure of bargaining on the other. So far we have assumed that both are exogenous, but in many cases there is room for manipulation. The following discussion is informal, a rigorous treatment would have to incorporate the decisions with respect to bargaining structure and payoff manipulation into the structure of the game tree.

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<sup>12</sup>Abreu and Gul (2000) also provide a detailed discussion of the related literature.

<sup>13</sup>Krishna and Serrano (1996) consider the case where  $n$  players bargain over a pie of fixed size. Under their bargaining procedure, the equilibrium agreement approximates the  $n$ -player Nash solution if players are patient. Under different bargaining procedures this need not be the case.

Assume that we are to advise country  $A$  and that our concern is total welfare. Assume further that total welfare is highest if bilateral open skies are agreed on so that our interests are also  $A$ 's (otherwise we would advise  $B$ ). Depending on the other conditions, the following advice may be in order:

1. If country  $B$  is strong, make it weak. One way to do this is to sweeten bilateral open skies, such that  $\beta_2 > \beta_0$ . For example, one might grant route traffic royalties or bundle air service negotiations with non-aviation quid pro quos which are in the interest of  $B$ . Another way of making  $B$  weak is to spoil the status quo and thus achieve  $\beta_2 > \beta_0$ . This may be accomplished if country  $A$  sets standards (e.g. technical) that are costly to achieve for  $B$ .<sup>14</sup>
2. If country  $A$  is weak, get strong (get  $\alpha_0 > \alpha_1$ ). Country  $A$  may try to make unilateral open skies costly to achieve, for example by passing according legislation, by making public statements and by mobilizing special interest groups. This gives credibility to the threat of not opening up unilaterally if  $B$  fails to approve to bilateral open skies.
3. If country  $A$  is weak, appear strong. Emphasizing that one is very happy with the status quo and considers unilateral opening as harmful may plant a seed of doubt regarding the true nature of  $A$  into some  $B$ . As we have seen before, even a very small initial assessment of  $A$  being strong can be sufficient for  $A$  to build a reputation.
4. Choose the right order of bargaining partners. First, signing open skies agreements with like-minded countries may be convenient, but it may also seriously deteriorate the bargaining position vis-à-vis less liberal countries. If only few agreements have been signed so far, there is a much stronger case for  $A$  to build a reputation and the less liberal countries, knowing this, may be more prone to agree on bilateral open skies at this stage.
5. Choose the right intervals of bargaining. By changing the time between bargaining rounds,  $A$  can influence the discount factor and hence the equilibrium outcome if both players are weak. For example take the case where  $\alpha_1 = 9$ ,  $\alpha_2 = 10$ ,  $\beta_1 = 10$  and  $\beta_2 = 5$ . Both countries discount at 6.38 percent per year. Now take the game  $\Gamma_T(A^w, B^w)$ . If

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<sup>14</sup>For example, the Dutch Government supposedly threatened to withhold payments to NATO until the U.S. granted some concessions to KLM (Hanlon, 1996, p. 80).

bargaining takes place every second year, then we get  $\rho = 0,8836$ . It follows that  $\alpha_1 > \rho\alpha_2$  and  $\beta_2 < \rho\beta_1$ , resulting in unilateral opening of A in equilibrium. If bargaining takes place every year, we get  $\rho = 0,94$ . Then it holds that  $\alpha_1 < \rho\alpha_2$ , resulting in bilateral open skies in equilibrium.

6. Avoid wars of attrition. As these wars soak up all of the additional rents, they are in nobody's interest. So in the case of complete information, try to fix an end date of bargaining. In the case of two-sided uncertainty, employ an economic adviser to reduce uncertainty about payoffs and types of players.

Although there are many reasons for less liberal countries to reject bilateral open skies, there are nearly as many means to fabricate the bargaining protocol and to manipulate payoffs. The above analysis provides guidance how and to what extent payoffs have to be corrected and how bargaining should be structured to achieve a socially desirable outcome.

## REFERENCES

- Abreu, D. and Faruk G. (2000). "Bargaining and Reputation," *Econometrica* 68, 85–117.
- Australia's Commonwealth Department of Transport and Regional Services. (1999, June). *International Air Services: Joint Statement of the Minister of Transport and Regional Services and the Treasurer*, Canberra.
- "Cabotage in Canada?" (2000, June 9). *Air Transport World*, 9.
- Forsyth, P. (2000, February). "Promoting Trade in Airline Services." Third Hamburg Aviation Conference, Hamburg.
- Fudenberg, D. and Jean T. (1991). *Game Theory*. Cambridge, MA: MIT Press.
- Hanlon, P. (1996). *Global Airlines: Competition in a Transnational Industry*. Oxford: Butterworth-Heinemann.
- Harsanyi, J. C. (1987). "Bargaining" in: John Eatwell et al. (eds.). *The New Palgrave*. London: Macmillan.
- Holler, M. J. and Illing, G. (1990). *Einführung in die Spieltheorie*. Berlin: Springer.
- Kreps, D. M. and Wilson, R. (1982). "Reputation and Imperfect Information." *Journal of Economic Theory* 27, 253–279.
- Krishna, V. and Serrano, R. (1996). "Multilateral Bargaining." *Review of Economic Studies* 63, 61–80.
- Milgrom, P. and Roberts, J. (1982). "Predation, Reputation, and Entry Deterrence." *Journal of Economic Theory* 27, 280–312.
- Morrell, P. (1998). "Air Transport Liberalization in Europe: The Progress so Far." *Journal of Air Transportation World Wide* 3, 42–61.

- Osborne, M. J. and Rubinstein, A. (1990). *Bargaining and Markets*. San Diego: Academic Press.
- Oum, T. H. (2000, February). "The Open Skies, International Trade, and Key Related Issues." Third Hamburg Aviation Conference, Hamburg.
- Selten, R. (1978). "The Chain-Store Paradox." *Theory and Decision* 9, 127–159.
- U.S. 'Open Skies' Negotiator Quits. (1999, October 9). *London Financial Times*.
- World Trade Organization. (1998, November). *Air Transport Services*. Background Note by the Secretariat, WTO, Geneva.