THE ROLE OF GAME THEORY IN SHIPPER-CARRIER NEGOTIATIONS

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ABSTRACT

In recent years, transportation deregulation has greatly changed the nature of business dealings between shippers and carriers. Published tariffs are now much less important and contract carriage much more so. Through negotiations, a carrier and shipper develop the terms and conditions of their contract. The most frequently discussed aspect of the negotiation process has thus concerned the negotiating "sessions" themselves, and how each side might best trade bargaining chips.

In this paper, we suggest ways to understand and enhance these negotiations through the use of non-cooperative game theory. Three different descriptive models are presented and illustrated using extended examples. The first model emphasizes the role of information in the general relationship between shipper and carrier, as they attempt to define a mutually beneficial contract. The second model highlights the competitive impacts on a carrier or shipper that limit the respective choices of action. The final model is a general procedure for more complex problems. Here, our illustration involves three participants— the shippers, carrier and buyer (or consignee)— who each have several strategies and counter-actions to strategic moves of the other two players.

INTRODUCTION

It has been a decade, the Stagner's Rail Act and the Motor-Carrier Act have changed the face of goods transportation in the United States. (These Acts have also influenced the U.S. to move, cautiously, down a similar path of deregulation.) One well-known impact of this legislation is that each carrier now faces greater competition, both intra-modal and extra-modal. As well, deregulation has turned upside-down the set of constraints by which a traffic manager earns his or her daily bread.

Rather than be an expert in shipment classification and rating schemes, today's traffic professional requires skills in bargaining and negotiation (Barry, 1989). Indeed, the majority of goods movements in the U.S. are now carried out under contractual arrangements, whether the carrier is a railroad or a trucking company (Wyse et al., 1987). A number of major shippers have instituted programs of education and retraining for traffic personnel, to help bring their skills in line with their new job descriptions.

The purpose of this paper is to structure the bargaining relationships involved in purchasing or supplying transportation services. Although the examples will be cast in the setting of TL or LTL trucking, the game-theoretic models proposed would apply to rail transport with only minor modifications. (Wyse et al., 1989, Appendix A) present a thorough checklist for contracts between shippers and railroads.

It will be helpful in what follows to distinguish two cases of transportation services. In Case 1, finished consumer goods are to be hauled from a shipper (say the manufacturer) to an intermediary that sells these goods to the ultimate consumer. The second setting involves goods sold to industrial concerns. These goods in Case 2 could, for example, be inputs (components or sub-assemblies) to that firm's own manufacturing process.

Case 1 can be modelled as a game involving two participants or players: the carrier C and the carrier B. The third entity, the buyer B of the merchandise, in fact represents a set \( \{ B_1, B_2, B_n, \ldots \} \) of dispersed wholesalers, distributors or retailers. Each \( B_i \) receives a portion of the output of \( B \), and no single one or two of the \( B_i \) is particularly more important than any of the others. Although C must develop and execute a number of routes to deliver merchandise to each \( B_i \), the game-theoretic setting of Case 1 need involve only the two players (S,C, B).

Case 2 can be cast in the framework of a three-person game involving (S, C, B). B is now much more localized and represents, for example, the national distribution center of a single wholesaler or retailer. Alternatively, in a Just-In-Time production system, the customer B denotes a single JIT-manufacturer (or at most a few, as in the automobile industry). In the JIT setting, S and B obviously have a joint stake in an ongoing relationship: S is a major supplier, on a regular and predictable basis, to a JIT-manu.
factor B. In some instances B manages, operates or selects a carrier for its "inbound" transportation (Gill and Yollmann, 1966). In others, S manages, operates or selects a carrier for its "outbound" operations, in which case the trust required between S and C may best be guaranteed by the sharing of the benefits of close cooperation (Bookbinder and Lynn, 1968). Generally, however, the interests or goals of the three players (S, C, B) need not be identical.

There are many specific procedures from game theory that can be applied in specific circumstances. The goal in this paper is to provide general-purpose approaches for understanding and dealing with the complex negotiation situations that can arise under deregulation. Three different models are presented, two of which are best applied to Case 1 above, while the other is suited to Case 2. First, the overall negotiating relationship between S and C is presented as the process of selecting a mutually beneficial contract. This point of view emphasizes the cooperative nature of negotiation, and also the manner in which lack of information can aid or hinder either side. The second model presented captures the fundamental forces on either S or C that limit his or her choice of action. The third model is a general procedure for dealing with more complex problems involving several participants, and thus is suited to the (S, C, B) situation.

A NEGOTIATION MODEL

We begin with the two-person (S,C) case. When negotiating, the natural way to think about the issues being negotiated is that a gain for one negotiator is a loss for the other. For example, if the linehaul charges are being negotiated, it is clear that a lower price is beneficial for S to about the same extent as it is detrimental for C. However, on other issues a benefit to S may only be a small loss for C, or may be neutral to C, or may also be beneficial to C.

Benefit to S, small loss to C:

Suppose S receives a "priority treatment" in the scheduling of trucks by C. C thus commits to a certain maximum lead time in getting a truck back to S, when that truck is required for a new delivery. As an example, C might be the first proposal by a particular carrier. All of the possible agreements are illustrated in Figure 1 and following figures. It is generally assumed

Benefit to S, no effect on C:

There may be a considerable savings to S if C is supplied with management reports by C. These would tabulate the various charges for different activities on a monthly or quarterly basis, and include claims information. This information may already be collected by C and could be supplied to S at negligible cost.

Benefit to S, benefit to C:

A volume commitment is often of benefit to both S and C. Both can plan with sure knowledge of cost/revenue and volume.

Similarly, there are other benefit combinations. One particularly important case is one that is of negligible benefit to S, but of large benefit to C. Such issues represent important bargaining chips to use to gain a concession elsewhere.

With these different kinds of issues possible, it is clear that when negotiating, one should try to recognize the effect of a proposal on the opposite party and trade off benefits and liabilities in order to achieve the best contract for oneself. One could possibly do this in a rigorous manner and convert all benefits and liabilities into their equivalent dollar value. For example, one could determine through some manner that the benefit to S of a dedicated service representative provided by C is $60,000, while the cost to C is $30,000 per year. By adding together such evaluations for all of the issues being negotiated, one could possibly estimate the net value to each party and thus have a rationale for a proposal. However, such calculations are hard to do. Many of the issues furnish no basis to determine a cost. For example, how do you estimate the value of improved documentation?

A good way to think about the problem of negotiating an agreement is to consider the diagram in Figure 1. The a axis is the benefit to S of a particular agreement, while the c axis is the benefit to C. No scales are shown in this diagram, but the units are generally of utility. As opposed to the last paragraph where one could think of all benefits in terms of their dollar value, utility provides another measure of benefit which is independent of money. A possible agreement could be represented by some point in the plane. For example, point C might be the first proposal by a particular carrier. All of the possible agreements can be bounded by a curve because the possible agreements can only be of limited benefit or detriment to S or C. The smallest area containing all possible agreements is called the contract space. For convenience, this general convex region is illustrated as an ellipse in Figure 1 and following figures.
must be in the segment of the contract space to the upper right of the conflict point. Second, consider the point \( s_1, c_1 \) in Figure 2. If this is the current proposal, any other proposal in the upper right quadrant from \( s_1, c_1 \) is better for both S and C. Consequently, it is unlikely, except in the case of poor communication, for an agreement to remain at that level. The parties will somehow improve the agreement in a northeasterly direction. However, consider the point \( s_2, c_2 \). There is no joint improvement possible from this position because any change will be less beneficial for one or both negotiators. The set of points of the contract space for which this is true is called the Pareto optimal set and occurs at the upper right edge of the contract space.

With these two considerations in mind, a very limited subset of the contract space stands out as being reasonable for a negotiated agreement. The agreement must be better than the conflict point for each negotiator and simultaneously be Pareto optimal. This set of contracts is called the negotiation set. The negotiation set is illustrated in Figures 3 and 4 by a heavy line. In Figure 3 the negotiation set is identical to the Pareto optimal set, while in Figure 4 the negotiation set is smaller than the Pareto optimal set because of the position of the conflict point.

Awareness of this structure for negotiation can aid a negotiator in several ways.

1) S prefers the conflict point as far right as possible, while C wants the contract point as far up as possible. Either of these will tend to reduce the negotiation zone in a manner favorable to the negotiator requesting the change, as long as the conflict point remains in the contract space. For example, Figure 4 illustrates the situation where C has shifted the conflict point in his favor. Comparison with Figure 3 shows that this removes from consideration all contracts simultaneously least favorable for C and most favorable for S. Although the parties have little control over the actual placement of the conflict point, they can sometimes control the perception of the conflict point by the opponent. For example, infiltration that alternate contracts are available to C from other shippers lowers the cost of no agreement to C. In other words, C could achieve a higher utility by not making an agreement with S, and thus the conflict point is moved upwards. This particular tactic is known as the whiplash (Edwards and White, 1976).

2) To select an offer that is beneficial for both negotiators, but better for the submitter, it is important to have a good understanding of the location of the conflict point. Information to establish this is vital. For S, this can be obtained, for example, by requesting costing information from C and from competing carriers C', C'', ..., (Berry, 1980).

3) Since the boundary of the negotiation set is not always clear, sometimes negotiators will propose contracts that are Pareto deficient. This means that there are contracts available with joint gains. In particular, it is always easier to move to a contract with joint gains, rather than to a contract with a gain for one side and a loss for the other. Also, it is unreasonable to compare the relative worth of different contracts to different negotiators - an apparently better contract for C, for example, may be perfectly satisfactory, even if there seems to be a much larger benefit to S. It is not possible to directly compare the scales on the two utility axes.

4) The maximum value of a contract is limited by the size of the contract space. Increasing the size of the contract space in the area of the negotiation set has a direct effect on the payoffs to both negotiators. The contract space can be expanded by, for example, finding a backhaul shipper, perhaps from another division of the same company.

In transportation-costing negotiations where the buyers are disparate, the main participants are S and C. The courses of action, called strategies, can be chosen to capture various aspects of the relationship. For example, consider the issue of fundamental negotiation styles. An advantages can be gained if the negotiators are approached in an aggressive manner. This may involve misrepresentation, such as whiplash, or simply a confrontational presentation. On the other hand, benefits can also be gained when both parties are open and cooperative.

Figure 3 describes this relationship as a 2x2 game in normal form. S has two strategies, labeled "soft" and "hard", represented by two rows of the matrix, while C has two strategies as columns. "Soft" corresponds to an open, cooperative style, while "hard" is confrontational. In such a game the negotiators are called players. The cells of the matrix represent the outcomes where each of the players has taken the corresponding strategy. The numbers in the cells denote the ordinal ranking of the outcome for S and C respectively, with 4 being most preferred and 1 least preferred. To illustrate the difference between "Hard" and "Soft" negotiating styles, consider the following dialogue between S and C. In each instance, it is assumed that C speaks first. Two possible answers are provided to S depending on whether he or she has a Hard or Soft style.

C: These are LTL shipments. The price will obviously have to be higher.
S. Hard - You have other customers. Your job as a carrier is to find ways to fill the truck.

Soft - Naturally, we are prepared to discuss a higher price for a premium service.

or Soft - Let’s try to find some additional things I’ll talk to the other divisions of the company.

C - Good. Now we have a greater volume of business. But the flow is still in one direction. I need a higher price per hundredweight.

S - Hard - That’s your problem. Another carrier told us he already has a bookhaul customer.

Soft - Maybe we can help find a bookhaul. A couple of our suppliers are not too far away from the general area of B.

C - Now lets talk about lead time. I can’t promise to change the delivery schedule on less than two days notice, if this would require an additional truck.

S - Hard - Why not? You have radio communication with your trucks, and supposedly a state-of-the-art system.

Soft - Not even for a premium price on such changes? How about if we commit to an annual upper bound on the number of such changes?

Each player must prefer the situation where his opponent is open and cooperative while he is aggressive, and least prefers the opposite situation. The second most preferred for both is where they are each cooperative. The second worst situation is where they are both assertive. The game model shown is Figure 5 in many circumstances. From a different application, it has taken the name “Prisoner’s Dilemma (Axelrod, 1984; Luce and Raiffa, 1967).”

The resulting model can provide some useful information.

1) Consider the point of view of S if C is committed to a “soft” strategy. He has the choice of “soft” and getting his second best outcome, or “hard” and getting his best outcome. He would choose “hard”. If C was committed to the “hard” strategy, the decision for S would be between “soft” and getting his worst outcome, and “hard” and getting his second worst. Again, he would choose “hard”. Also, notice that the decisions for C are identical - the game model is symmetric. Consequently, under this logic, the negotiators will both select the “hard” strategy, and the outcome with 2, 2 rankings will result.

2) On the other hand, the 3, 3 outcome is preferred by both negotiators to the 2, 2 outcome. The problem is how to get there, because a change in strategy by only a single player is a change to that player’s least preferred outcome. It somehow requires a joint change - both negotiators starting to cooperate. This can in practice be fostered by communicating about the negotiating process itself. If both parties recognize that mutual confrontation is a lose-lose situation, sometimes improvement to the win-win case is possible.

3) Another way of achieving the 3, 3 outcome is to go there in the first place. By initially adopting a cooperative manner, and verifying that the opposition does also, the two can achieve beneficial outcomes. If the opposition is aggressive, the strategy can be changed with the worst outcome only occurring during a short transition. Note that there are mutual sanctions against deviating from the 3, 3 outcome once it has been achieved. If one player moves from his second best outcome to his best outcome, the natural response by the other player is to place the former player in his second worst outcome. This adverse consequence may constrain a foresighted player from moving from his second best outcome in the first place.

Some interesting contests were run and reported by Axelrod (1984) on Prisoner’s Dilemma which suggest that a “winner” in these sorts of strategic relationships exhibits the following characteristic:

1) He is "nice". In other words, the initial strategy selection is to cooperate.

2) He retaliates. As soon as the opposition acts confrontational, he also selects the aggressive strategy.

3) He is forgiving. If the opposition changes course, he quickly also takes the soft line.

One other interesting result is that the experiments suggest that a negotiator who takes the above approach may indeed lose in the sense of gain less against a particular opponent. Each new opponent to cooperate, he will end up making many more deals than a negotiator taking a different approach, in the long run he will be better off.

OPTION FORM MODELS

Before the actual negotiations begin, a question will usually arise on the terms of sale, say FOB origin versus FOB destination. It is the marketing people who will make this choice, albeit with help from the traffic personnel. If "FOB destination" is the ultimate decision, it is the consignee B who will select a common carrier (C, C, ..) or the private fleet of B. Alternatively, the decision "FOB destination" then delegates to the shipper S the choice of its own fleet or of which common carrier to appoint. Having decided the terms of sale, S can be left to the negotiators to agree on a transport contract.

In either case, whether the party negotiating with the carrier is the consignee B or the shipper S, the two person game model can help. However, in some circumstances, it can be important to consider the interactions of more than two players. In the normal form of the game used in Section 3, each of the players requires a spatial dimension - S controlled the rows while C controlled the columns. Although this notation can handle, to a certain degree, situations where the participants have more than two strategies, it becomes awkward when there are three or more players. In this case, a different notation called the option form is more useful.

In the option form the players are listed one below the other in a column. Beside each player are listed options. An option is a course of action for the player, and is different from a strategy in that strategies for a player are mutually exclusive, while options need not.

As an example, consider a particular hypothetically situation involving the (S, C, B) important. Further, the Smith Manufacturing currently ships (via Cooper Carriers) to the Buyer (Burns Corp.), where the company names have been chosen mononymically to agree with the symbols (S, C, B). The contract between Smith and Burns is FOB destination, with Smith responsible for the choice of carrier underneath Cooper. There is thus an ongoing relationship among the three parties. However, a number of possibilities exist in the way things are done. In particular, Cooper Carriers is experiencing increased costs and wants to improve its profitability. Smith Manufacturing and Burns Corp. can respond in a number of ways. In more detail, these options are shown in Table 1.

Each of the three decision makers guards the various possible options differently. One particular option may be very important for a given player, and not important for another. Similarly, one player may wish that an option occurs, while a second player wants the option not to be taken. The different views of the decision makers can be indicated by listing every option for each in a column, from most important to least important to each decision maker.

The most important issue to Smith is that Cooper does not increase its rates and next to that, not lower its level of service. Also of
The role of Game Theory in Shipper-Carrier Negotiations

TABLE 1
Options for S, C, and B in the Three Person Game

<table>
<thead>
<tr>
<th>Decision Maker</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smith Manufacturing (S)</td>
<td>1) Use own fleet - Stop using Cooper and service Burns using shipper's own fleet - FOB destination.</td>
</tr>
<tr>
<td></td>
<td>2) Use Carrier C' - Use a common carrier other than Cooper to service Burns.</td>
</tr>
<tr>
<td></td>
<td>3) FOB Origin - Request that Burns be responsible for shipping.</td>
</tr>
<tr>
<td>Cooper Carriers (C)</td>
<td>4) Lower Service - Reduce the quality and features of the services provided to Smith and Burns in order to decrease costs.</td>
</tr>
<tr>
<td></td>
<td>5) Raise Rates - Increase shipping charges to Smith in order to increase revenue.</td>
</tr>
<tr>
<td>Burns Corp. (B)</td>
<td>6) FOB Origin - Request to handle own shipping, either with own fleet or another common carrier.</td>
</tr>
<tr>
<td></td>
<td>7) Demand Service - Demand a higher level of service than currently being provided.</td>
</tr>
</tbody>
</table>

The high importance is that Burns should not expect a greater level of service. Further, Smith does not wish to use its own fleet. (Note that this is about middle level in importance to the shipper. Such a ranking could arise for several reasons. For example, Smith’s own trucks may be currently utilized to an extent that it would be difficult to fit in the additional (S,B) trips. Alternatively, in that particular lane, some effort may be required to obtain a backhaul.) The statement “if 6” indicates that should the Carrier’s rates be raised, Smith would prefer to switch to another Carrier C’; otherwise, Smith would prefer not to switch (note that 2 if 5 implies, in this notation, 2 if 5). It is of lesser concern to the shipper Smith if the Buyer Burns wishes to be responsible for its own transport. This can be seen by the low position of “6” in that column, as well as by the entry “3 if 6”, which indicates Smith would not be opposed to such a move by Burns.

The issue first in importance for Cooper is that business not be switched to carrier C’. Almost as important is that, if Smith does not request that Burns be responsible for the transport - since then (if Burns agreed) either C’ or Burns’ fleet would deliver the deliveries currently carried by Cooper. The two subsequent entries for Cooper have a bit more subtle interpretation. “if 2 and 3” is shorthand for “if Smith does not use Carrier C’ nor request that Burns be responsible for transport”. In that case, Cooper’s preferred alternative is to raise rates, and next preferred is to lower service. Finally, the last entry indicates that Cooper does not want Smith to use its fleet. The options not mentioned in the listing for Cooper in Table 2, options 6 and 7, simply have no importance at all for Cooper. Its customer is Smith, so that the options available to Burns, which may in fact be quite significant in their effect on Cooper, are not recognized by Cooper in this case as meaningful in Cooper’s decision making.

From the point of view of Burns, it is of greatest importance that Cooper not lower service. Should Cooper make such an attempt, Burns will demand that service be maintained at its present level. Next in importance, Burns prefers that Cooper not raise its rates. In the case that Cooper does either lower service or increase rates, Burns would react: preferably Burns would ask that Smith carry out the deliveries itself, or secondly, that shipments be carried in the future by a competing carrier C’. The entries in Table 2 of least importance to Burns are “2 if 5” and “3 if 6”, are essentially the same. They differ only in whether it is Burns or Smith who initiates the suggestion “FOB Origin”, but otherwise, it is Burns who would be responsible for arranging the transport.

Once the players, options, and preferences have been specified, similar principles can be applied to analyze the model as were used for the 2x2 game. However, such calculations can be complex, and using a computer program is advised. For the case presented above, the DecisionMaker (Fraser and Hipel, 1968) program was used. The DecisionMaker program automatically analyzes a complex game model in order to determine which outcomes have special properties. Many outcomes will be insensitive because at least one player can unilaterally improve his position. Outcomes that are stable for all players are possible resolutions, and may be further classified according to the forces inducing stability for the players. If a player cannot unilaterally improve his position from a given outcome, the stability for that player is said to be strong. If a player can unilaterally improve his position, but other players can subsequently place him in a less preferred position, the stability for the original player is said to be weak. The number of moves necessary in order to place a player in a less preferred outcome is a measure of the weakness of the stability. For example, in the Prisoner’s Dilemma of Figure 6, the (2,2) outcomes exhibit strong stability for both players, while the (3,3) outcome is weakly stable (in one move) for both.

The analysis of the (S,C,B) case reveals a variety of important information about the possible resolutions. There are three possible resolutions. These are denoted by columns of Y’s and N’s in Table 3, where a “Y” means that the corresponding option is taken and an “N” means that it is not. This indicates that for all other outcomes, there is some option available by one of the players to change the outcome to a different one; only these three equilibrium outcomes could persist, if they arose.

TABLE 3
Options for S, C, and B in the Three Person Game

<table>
<thead>
<tr>
<th>Decision Maker and Options</th>
<th>Possible Resolutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smith Manufacturing (S)</td>
<td>N N N</td>
</tr>
<tr>
<td>1) Use own fleet</td>
<td>N N N</td>
</tr>
<tr>
<td>2) Use Carrier C’</td>
<td>N Y N</td>
</tr>
<tr>
<td>3) FOB Origin</td>
<td>Y N N</td>
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</tr>
<tr>
<td>5) Raise Rates</td>
<td>Y N N</td>
</tr>
<tr>
<td>Burns Corp. (B)</td>
<td>N N Y</td>
</tr>
<tr>
<td>6) FOB Origin</td>
<td>Y N N</td>
</tr>
<tr>
<td>7) Demand Service</td>
<td>Y N N</td>
</tr>
</tbody>
</table>
In the first possible resolution, Cooper lowers its level of service. Burns responds by demanding a higher level of service. Smith, meanwhile, has nothing it can do to improve the situation. Cooper has reduced costs, but Burns is left unsatisfied. That will make Smith's job more difficult during future contract negotiations. This result is "strong".

In the second possible resolution, Smith requests that Burns accept an FOB origin relationship. In this case, Cooper cannot gain a preferred outcome unless, as indicated in its preferences, it will only lower service if Smith has requested a move to FOB origin (not to a different carrier). However, Burns is reasonably happy. Burns prefers FOB destination (4), and will continue to negotiate under that premise, but the request by Smith is of very little importance to the buyer. This resolution is also "strong".

In the third resolution, Smith and Burns have jointly proposed a change to FOB origin. Cooper has responded by maintaining service with no changes in rates. This resolution is "weak".

As can be seen in Table 3, the results indicate that there are some common features of the possible resolutions:

- Smith will not resort to using its own carrier C.
- Smith will not change to another carrier C.
- Cooper will not raise the rates charged to Smith.

Further analysis can be done to determine the natural consequence of the players individually acting in their immediate self-interest from the status quo. In this case, the result is the unsatisfactory situation of Cooper lowering its services and leaving Burns unsatisfied. In other words, given the normal course of events, Cooper will be the "winner" by achieving its goals of improved profitability at the expense of Burns being dissatisfied and Smith being put in a poor position for future bargaining with Burns.

However, Smith has the power to forestall this consequence. Note from Table 2 that Burns will never choose to request or agree to an FOB origin contract (4) even if Smith initiates such a request (3). Further, note again from Table 2 that Cooper will not lower its level of service if Smith requests FOB origin (4 if 2 & 3 implies, in this notation, 4 if 2 or 3). Consequently Smith can improve the expected outcome in this situation simply by boldly announcing that it wants to move to an FOB origin relationship, knowing that Burns will not support the request. This announcement serves as a threat to Cooper, and restrains Cooper from lowering the level of its services. In short, the game theory analysis has permitted Smith to identify a course of action that results in a beneficial outcome for both itself and its customer. Of course a particular negotiator may not wish to misrepresent his true intentions, however it is always worth-while to recognize the potential for mis-representation by any of the parties involved in a negotiation.

In general, the use of the option form for analyzing a more Conflict Analysis helps decision making in several ways:

- Explains why an outcome is stable or unstable for a given decision maker.
- Forecasts compromise solutions.
- Provides the option to choose the option that maintains the most likely resolution.
- Allows extensive sensitivity analyses.
- Points out where more information is needed.
- Provides easy communication about a conflict with others.
- Describes paths for optimal decision making.

CONCLUSIONS

In this paper, we have illustrated the use of game theory in shipper-carrer negotiations, both for understanding the overall process and for enhancing the negotiations themselves. Three models were presented in sequence from the general to more specific. The first addressed the overall relationship between carrier and shipper emphasizing the cooperative nature of negotiations, using a utility-space representation (Figure 1). The second model concerned a 2x2 ordinal game. Our particular illustration concentrated on differences in negotiating styles (hard versus soft) (Figure 8).

The final model (Tables 1-3) had three players: shipper, carrier, and buyer (consignee). Although this model could be the basis for "mediation" among these parties, with all three present at one time, it would not often be employed that way. Rather, the model user would be working for the carrier, say, and trying to guess the preferences of the carrier and consignee. Sensitivity analysis would then yield a framework for subsequent pairwise negotiations.

Additional research could aim at a still more specific model, using cardinal utility (Owen, 1982). Cardinal payoffs, expressed on a continuous real number scale, require more information than that assumed for the ordinal game-theoretic models of the present article. More information could be available, e.g., specific carrier costs. However, very much more data is needed to apply the methods of the game theory to practical problems. We thus feel that there are opportunities to further explore the grey area between the latter techniques and those of the present paper, taking advantage of that information which is available or could be.