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## An Application of Computerized Decision Tree Models in Management-Union Bargaining

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# An Application of Computerized Decision Tree Models in Management-Union Bargaining

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A computerized model to assist in management-union negotiations is presented. Results indicate that benefits extend beyond improved decision-making.

For a management team assigned to negotiate a labor contract with a union, often the only perceived certainty is that the outcome will be viewed as no win: either they will give away more than absolutely necessary or they could cause a costly strike that the company can ill-afford. To add to this burden, team members often must debate upper management prior to engaging the union in verbal combat. The team's recommendations are generally difficult to defend since they are based on members' intuition. Thus if management has different intuition, a pre-bargaining stalemate is reached. Whatever the outcome, both the bargaining team and management are vulnerable to swings of emotion during the bargaining process.

This paper will show how a decision tree approach was used to develop reasonable bargaining positions that helped reduce the no win atmosphere of bargaining. In general, the model and its computer application offered the following benefits:

1. The model helped the bargaining team to select preferred positions/strategies from a large set of possible bargaining positions/strategies.
2. The model can improve communication between upper management and the bargaining team by focussing the application of intuition on only those model components that are uncertain. Therefore, rather than debate the preferred position, it is more productive to debate the inputs to the model that lead to the preferred position.
3. The model easily demonstrated the risks of alternative bargaining positions/strategies.

4. The model increased the confidence of bargaining team members and made them less vulnerable to union tactics.

## Decision Modelling of the Bargaining Process

By most standards, the decision process and outcomes of management-union bargaining is simple. Management decides on the package it is prepared to offer and the union decides whether it will settle for the package or strike. What complicates the game slightly is that the game is played over multiple periods because each party believes that sometimes a strike may dislodge the opponent from an unfavorable position. Thus any bargaining position must consider subsequent moves in the event a settlement is not reached.

Figure 1 details how complex a decision tree of just 3 settlement packages can look after 3 strike periods (plus one period prior to strike). In spite of the apparent complexity, the structure is really quite simple. As shown in Figure 1, management can decide at time period 0 (prior to strike) to offer either package 1, 2 or 3. In the same time period, the union can agree to settle or strike. If a strike results, management can, during the first period of strike, offer settlement packages 1, 2 or 3. In the accompanying computer application, a simplifying assumption was made that management cannot offer a package of less attractiveness to the union which earlier rejected a package. In this way, subsequent expansion of the tree is greatly reduced. Therefore, if packages are ordered in increasing attraction to the union, management cannot offer package 1 to a union which struck on an offer of package 2.

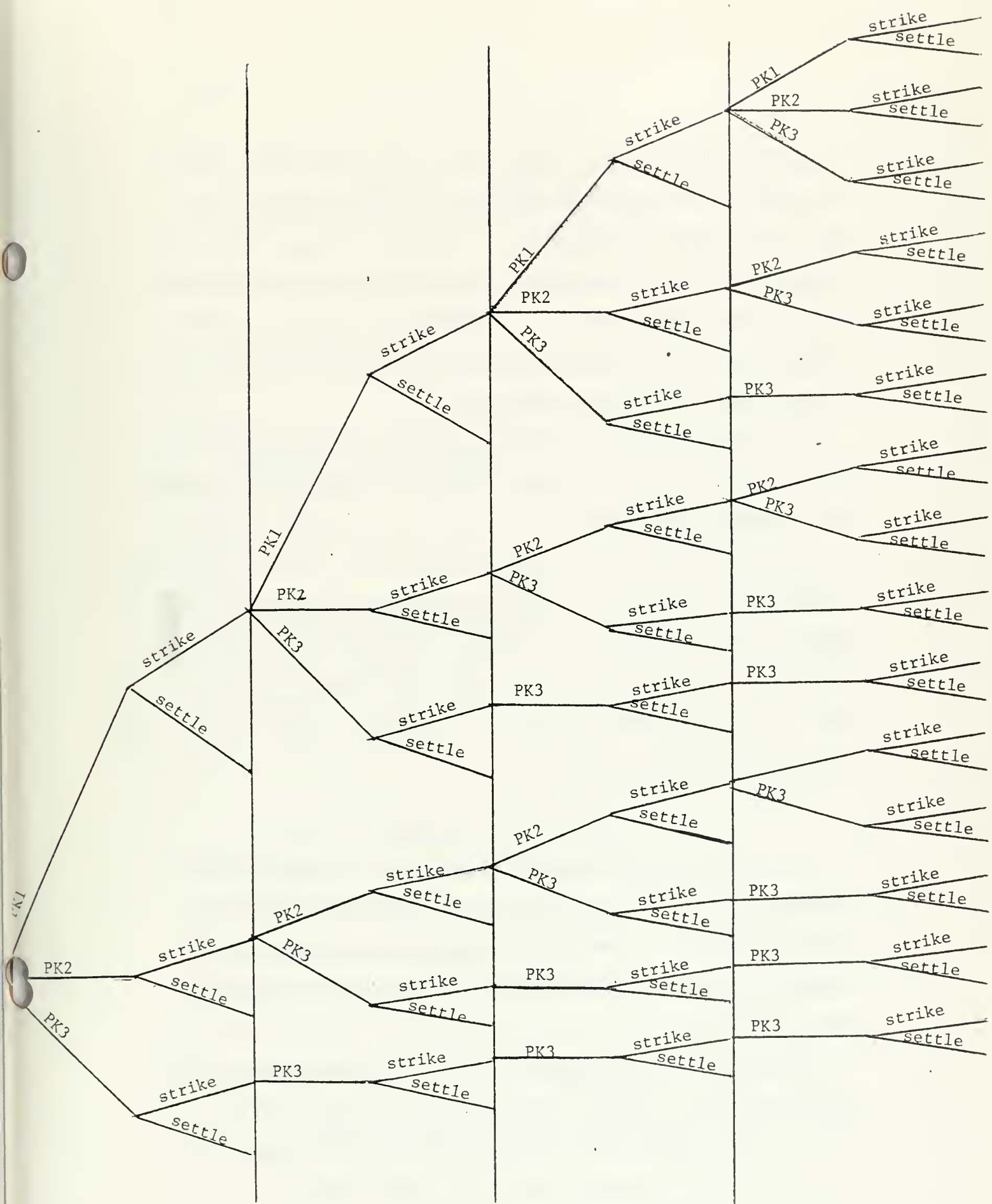


Figure 1. Decision Tree for Four Period-3 Package Model

Although the management team may believe the negotiation process to be loaded with uncertainty, decision structuring indicates that there are a number of components to the decision that are known: the cost of the strike and the cost of the settlement package (discounted over the life of the contract) are generally calculable. The only uncertainty is whether the union will settle or strike for each of the packages during the various time periods.

Although modeling of settlement probabilities based on either statistical data or preposterior analysis would be possible, the approach that is generally most simple and acceptable to management is to use simple subjective probability judgments (that may be based on historical data). The general feeling is "each bargaining situation is different." These probabilities are simply anticipated union settlement probabilities for the alternative packages at different strike intervals. (See Figure 2 for the inputs in the computer program to be described in the next section.)

## Computational Procedures

The decision facing management here and now is "what settlement package should I next be prepared to offer the union?" Because the choice of a package at time 0 can constrain choices later on, it is necessary to determine the optimal path through the multi-stage decision tree of Figure 1.

A method of solution is to use a dynamic programming type of backward integration to determine optimal offers at period n and work backward to determine the optimal offer at time period 0. "Best decisions" are based on minimum expected loss (or in today's bargaining climate

```
PROGRAM   BARGAIN

HOW MANY PACKAGES TO CONSIDER?
? 3
A PERIOD IS HOW LONG?(E.G.1WEEK,2WEEKS)
? 1 week
HOW MANY STRIKE PERIODS MAXIMUM?(UP TO 8 ALLOWED)
? 3
IF NOT SETTLED BY THIS TIME,IT IS ASSUMED TO BE SETTLED
AFTER 6 STRIKE PERIODS WITH PACKAGE 3 AS THE RESULT
WHAT'S THE COST OF STRIKE FOR THE NUMBER 1 PERIOD(1 WEEK)?
? 20000
WHAT'S THE COST OF STRIKE FOR THE NUMBER 2 PERIOD(1 WEEK)?
? 24000
WHAT'S THE COST OF STRIKE FOR THE NUMBER 3 PERIOD(1 WEEK)?
? 35000
WHAT'S THE COST OF STRIKE FOR THE NUMBER 4 PERIOD(1 WEEK)?
? 38000
WHAT'S THE COST OF STRIKE FOR THE NUMBER 5 PERIOD(1 WEEK)?
? 40000
WHAT'S THE COST OF STRIKE FOR THE NUMBER 6 PERIOD(1 WEEK)?
? 40000
ORDER PACKAGES BY INCREASING ATTRACTION TO UNION
WHAT IS THE COST PER PACKAGE?
PACKAGE 1 ?
? 10000
PACKAGE 2 ?
? 40000
PACKAGE 3 ?
? 95000
WHAT'S THE PROBABILITY OF SETTLING FOR
PACKAGE 1 AFTER  0 PERIODS OF STRIKE?
? .1
PACKAGE 1 AFTER  1 PERIODS OF STRIKE?
? .15
PACKAGE 1 AFTER  2 PERIODS OF STRIKE?
? .18
PACKAGE 1 AFTER  3 PERIODS OF STRIKE?
? .2
PACKAGE 2 AFTER  0 PERIODS OF STRIKE?
? .3
PACKAGE 2 AFTER  1 PERIODS OF STRIKE?
? .35
PACKAGE 2 AFTER  2 PERIODS OF STRIKE?
? .4
PACKAGE 2 AFTER  3 PERIODS OF STRIKE?
? .5
PACKAGE 3 AFTER  0 PERIODS OF STRIKE?
? .8
PACKAGE 3 AFTER  1 PERIODS OF STRIKE?
? .9
PACKAGE 3 AFTER  2 PERIODS OF STRIKE?
? .95
PACKAGE 3 AFTER  3 PERIODS OF STRIKE?
? .99
```

Figure 2. Sample Inputs to Computer Model

maybe even maximum expected gain). More complicated algorithms based on risk-return tradeoffs are possible but require more demands of management. However, because risk concerns are important, the program deliberately avoids the choice of a "best position." Instead the expected loss of each option as well as a probability distribution of outcomes (see Figure 3) is shown. Traditional variance measures are avoided since a graphic display is more meaningful to management. In addition, the best moves following the initial position choice are output (see Figure 4).

The program to process this has been written in BASIC language and has been run on a Control Data mainframe and IBM and Radio Shack personal computers. BASIC allows a simple questioning interaction between negotiator and computer and allows the program to be run on most microcomputers.

## Results

The initial objective of the program was to develop a tool whereby the negotiator could realize more favorable bargaining outcome through improved decision-making. This, as it turns out, was realized, but by products of this application turned out to be much more significant than the mere determination of the optimal bargaining position.

For example, the first use of the model convinced the users that good data inputs would be important. In response, the firm developed a microcomputer program that could calculate the package costs. Previously, calculations had been no trivial task given complicated cost of living allowance factors. Secondly the negotiating team felt that the tool made them more confident in establishing a meaningful dialog

```
THIS PERTAINS TO INITIAL OFFER OF PACK. 2 WITH SUBSEQ MOVES
 30                                                        R
 29                                                        R
 28                                                        R
 27                        I                               R
 26                        I                               R
 25                        I                               R
 24                        I                           Q   R
 23                        I                           Q   R
 22                        I                           Q   R
 21                        I                           Q   R
 20                        I                           Q   R
 19                        I                           Q   R
 18                        I                       O   Q   R
 17                        I                       O   Q   R
 16                        I                       O   Q   R
 15                        I                       O   Q   R
 14                        I                       O   Q   R
 13                        I                       O   Q   R
 12                        I                       O   Q   R
 11                        I                       O   Q   R
 10                        I                       O   Q   R
  9                        I                       O   Q   R
  8                        I                       O   Q   R
  7                        I                       O   Q   R
  6                        I                       O   Q   R
  5                        I                       O   Q   R
  4                        I                       O   Q   R
  3                        I                       O   Q   R
  2                        I                       O   Q   R
  1                        I                       O   Q   R
  0 A  B  C  D  E  F  G  H  I  J  K  L  M  N  O  P  Q  R  S  T
PACKAGE          2 EXPECTED LOSS=              -89812.1
```

Note: left column of numbers represents probability of dollar outcome represented by letters. A key as to letter outcomes is printed but not shown; for example here: \$-66,400 < outcome Q $\leq$ \$-52,300.

Figure 3. Sample Output for Offer of Package 2

| GIVEN AN OFFER OF PACKAGE | IN PERIOD | (STRIKE PERIOD) | THE BEST NEXT OFFER IS PACKAGE |
|---|---|---|---|
| 1 | 1 | 0 | 2 |
| 1 | 2 | 1 | 2 |
| 1 | 3 | 2 | 3 |
| 1 | 4 | 3 | 3 |
| 2 | 1 | 0 | 2 |
| 2 | 2 | 1 | 2 |
| 2 | 3 | 2 | 3 |
| 2 | 4 | 3 | 3 |
| 3 | 1 | 0 | 3 |
| 3 | 2 | 1 | 3 |
| 3 | 3 | 2 | 3 |
| 3 | 4 | 3 | 3 |

Figure 4. Output Indicating Best Moves Following Initial Offer

with upper management prior to actual bargaining. In the bargaining team there was the pervasive feeling that management was often unaware of the risks of alternative bargaining strategies. Now a tool was available to demonstrate those risks. To further demonstrate the outcome of strategies of particular interest to upper management, a feature was added that allowed the expected value and risk of management's preferred strategies to be seen (see Figure 5).

Although different use strategies of the model are still being tested, the first actual application did result in a solution which increased the confidence of all members of the bargaining strategy group. The process which was used and the results produced were the following:

1. Five committee members decided on six diverse packages to be offered to the union

2. Consensus was developed on the cost of the packages (using the previously described microcomputer estimation package) as well as the cost of each period of strike

3. Each member of the committee interacted with the computer by inputting his probabilities of union settlement over the time horizons considered.

4. One of two "adjacent" settlement packages (Packages 2 and 3) were favored by all group members. It was interesting to note that even though diverse probabilities produced quite different levels, often the rank order of packages was similar across team members. Of the two packages the one not favored was the second choice of each group member.

5. Variations around and between the two settlement packages (i.e., 2A, 2B, 2C, 2D, 2E) were considered and again the analysis was done. Two alternatives were selected although the bargaining committee prepared to enter negotiations with all five as options.

6. Discussions with upper management produced an authority for bargaining which went beyond the computer model-assisted settlement point which gave the bargaining team some latitude during negotiations.

```
WOULD YOU LIKE TO SEE
THE RESULTS OF ANY MORE
STRATEGIES?TYPE Y FOR YES AND N FOR NO
? Y
WHAT PACKAGE WOULD YOU LIKE TO OFFER..
AFTER 0 PERIODS OF STRIKE(0=BEFORE STRIKE)
? 1
WHAT PACKAGE WOULD YOU LIKE TO OFFER..
AFTER 1 PERIODS OF STRIKE(0=BEFORE STRIKE)
? 1
WHAT PACKAGE WOULD YOU LIKE TO OFFER..
AFTER 2 PERIODS OF STRIKE(0=BEFORE STRIKE)
? 2
WHAT PACKAGE WOULD YOU LIKE TO OFFER..
AFTER 3 PERIODS OF STRIKE(0=BEFORE STRIKE)
? 3
THE FOLLOWING APPLIES TO REQUESTED STRATEGY 1  1  2  3
 45                          I
 44                          I
 43                          I
 42                          I
 41                          I
 40                          I
 39                          I
 38                          I
 37                          I
 36                          I
 35                          I
 34                          I
 33                          I
 32                          I
 31                          I
 30                          I                    0
 29                          I                    0
 28                          I                    0
 27                          I                    0
 26                          I                    0
 25                          I                    0
 24                          I                    0
 23                          I                    0
 22                          I                    0
 21                          I                    0
 20                          I                    0
 19                          I                    0
 18                          I                    0
 17                          I                    0
 16                          I                    0
 15                          I                    0
 14                          I                    0
 13                          I                    0                    S
 12                          I                    0                    S
 11                          I                    0                    S
 10                          I                    0                    S   T
  9                          I                    0                    S   T
  8                          I                    0                    S   T
  7                          I                    0                    S   T
  6                          I                    0                    S   T
  5                          I                    0                    S   T
  4                          I                    0                    S   T
  3                          I                    0                    S   T
  2                          I                    0                    S   T
  1                          I                    0                    S   T
    A  B  C  D  E  F  G  H  I  J  K  L  M  N  O  P  Q  R  S  T
EXPECTED LOSS=                    -111162.
```

Figure 5.

Solicitation and Provision of Management's Preferred Strategy With Subsequent Output

During the strategy session, the ease with which results could be seen without time consuming calculations contributed to an atmosphere of looking at a large number of options.

Although a sample of one observation, the settlement agreed to by management and the union was similar to those considered by the bargaining team; three weeks of negotiation produced some fine tuning and a settlement (without a strike) that was agreeable to both parties. The bargaining strategy session was conducted by the members of one division of the client firm along with two members of the corporate industrial relations department. Other than the head of the affected division being involved, no upper management from corporate or other divisions are aware of the model. It is believed that the approach of using subjective probabilities along with computer assistance may be a little revolutionary until some success stories are build up. The model is planned for future usage, and since approximately six contracts are negotiated by various divisions each year, quick familiarity and documentation of effectiveness is expected.

## Variations

Although the example of Figures 1-5 show typical manufacturing inputs, the actual bargaining unit where the model was applied was a parts order processing facility which has a strike cost per period which decreases with time (initially orders are lost, but eventually other warehouses take up the slack reducing the cost. In fact sometime the strike cost can become negative--therefore representing positive cash flow). In contrast, most manufacturing plants will experience

a strike cost that increases with time. The model is equally adaptable to either circumstance. It will also handle concessions where the cost of packages is negative thereby resulting in positive cash flow. (This is especially important in today's concessionary environment.)

In one trial circumstance, the model was applied to the situation where the company could either force a contract or let the union continue to work for another year without a contract. The union favored working without a contract because it believed its bargaining leverage to be better a year later. The model was used in conjunction with a decision tree that specified alternative economic environments for its firm one year in the future. The three expected results were then weighted by the probability of the economic environments to yield an overall expectation associated with delaying contract talks one year (see Figure 6).

Although a natural future extension to the model might be to pool probabilities from the different members of the bargaining strategy team (perhaps even weighting them based on confidence and/or past historical accuracy), a different approach is favored. Because the number of potential packages is almost infinite, conjoint analysis will be used to vary alternative package features. Resultant estimates as to team members' perceptions of union settlement--together with the cost program previously mentioned--will help develop a set of initial packages which seem to offer the maximum probability of settlement to cost ratio.

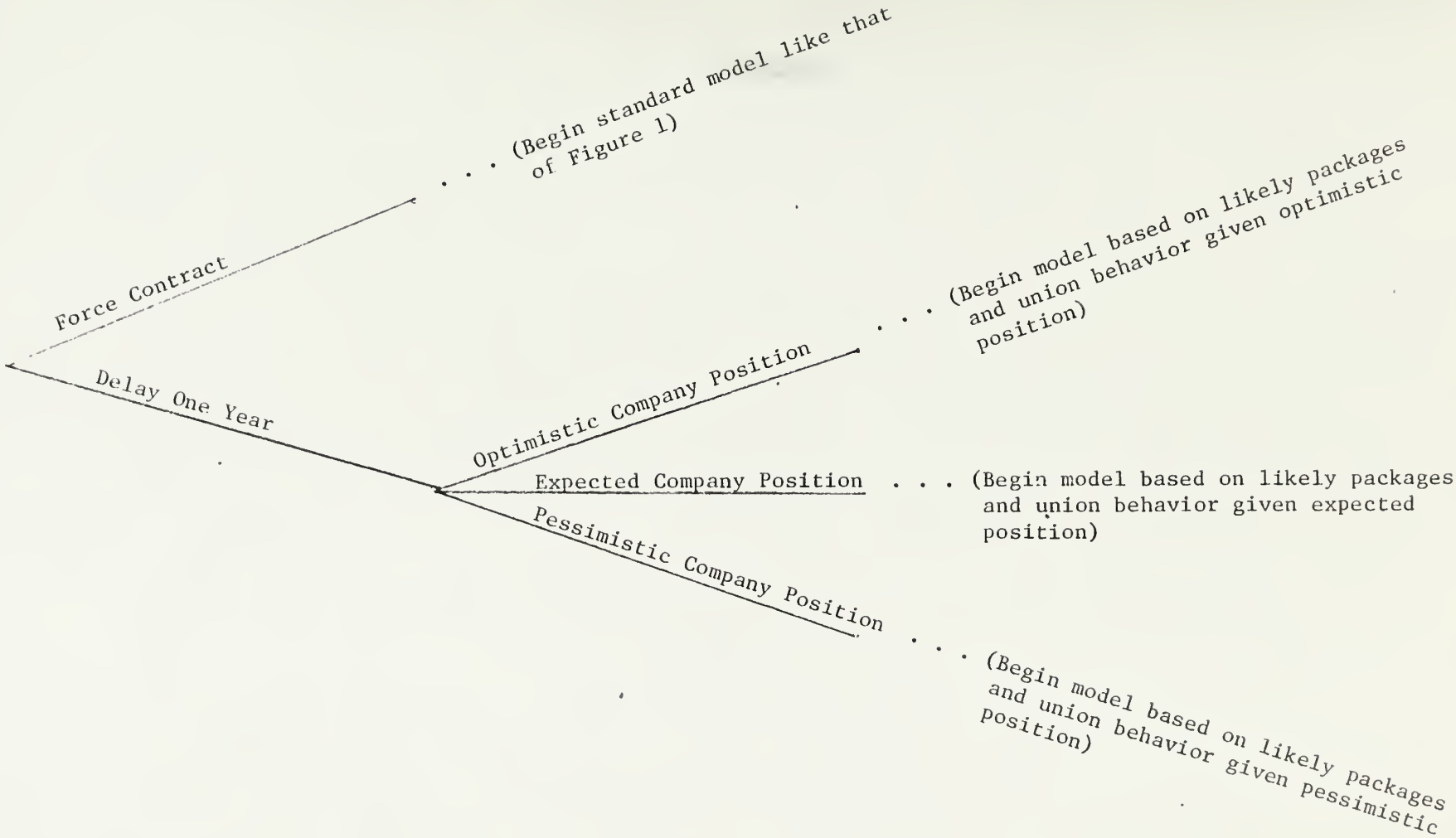


Figure 6. Forced Contract versus Delayed Contract