Appendix Two: A Bargaining Simulation*

Bargaining is a fundamental process in human society. It takes place whenever some resource, prize, or privilege needs to be divided or allocated. The purest form of bargaining appears when two contenders need to divide a quasi-continuous valuable between themselves. They have opposite objectives since the more one gets, the less the other does. However, they also have a common incentive to agree since failure to do so often results in costly conflict or stalemate. Bargaining can also take very complex forms involving several parties and valuables, some of which might not be easy to divide.

A particularly acute bargaining problem arises when one side has already appropriated the valuable in question and is fully enjoying its benefits. The party left out can always complain about the obvious inequity and make a polite request for a share of the assets. But, without a credible threat to implement moral, legal, or physical, retaliations it is unlikely to obtain any concession. The bargaining then becomes intertwined with the threat of moral condemnation, lawsuit, and possibly violence.

Examples from history, economics, business, politics, and sociology, among others, are abundant. Indeed, war is widely seen as the last resort in the anarchy of international relations once bargaining has failed. In a great majority of cases, war is preceded by a demand for concessions or an offer of terms. Herodotus, for instance, reports that the Greeks turned down the terms offered by Xerxes, King of Persia, before the battle of Salamis. Alexander the Great, King of Macedonia, similarly turned down the terms offered by Darius some 150 years later, before the battle of Gaugamela. The end of war often comes with a resumption of bargaining, once military capabilities and respective resolve have been well demonstrated. Hannibal's Carthage did accept the harsh terms of the Roman Scipio after the battle of Zana. And so did Vercingetorix at Alesia. Similarly, labor strikes and lockouts, lawsuits, and numerous other forms of pressure are often associated with the failure of bargaining and are a way of influencing the terms of its resumption.

The most basic bargaining structure when one side (the "defender") has appropriated the prize and the other (the "challenger") is demanding a share under the threat of costly action is pictured in Figure 1 below. The move structure is as follows:

The game starts at Node BRC (Start) in the upper-right corner with a challenger decision on what share x of the prize to demand (with an implied threat) or to request (politely) such a share x. Since the defender has not yet made an offer, it is assumed to be nil (y-0). In the case of a challenger request, time is on the defender's side and she can ponder the situation. She will therefore receive at Node II the payoff (1 unit) of enjoying the full prize for now while he gets nothing. Then, she will have to decide at Node BRD whether to submit to the challenger's demand, thus ending the game entirely, or to make an offer y in return, thus implicitly rejecting the challenger's demand. Shares x and y will be expressed as a percentage from 0% to 100%.[1] If the challenger made a threatening

[1] For simplicity fractions of a percent are not acceptable in the simulation.

demand x instead, the defender must decide at Node CRD whether to submit to x, thus ending the game, or to resist and open the door to possible escalation.

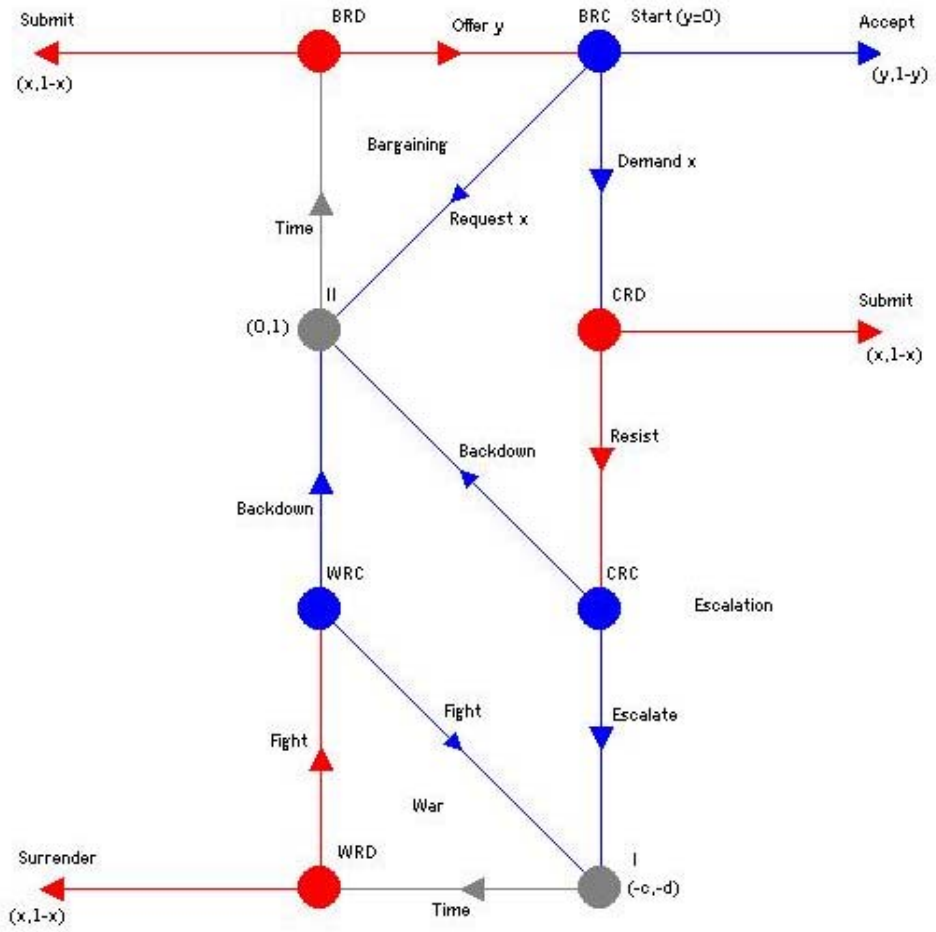

Figure 1: Bargaining and War

If the defender resists, the challenger at Node CRC must decide whether to back down, thus returning to Node II (and a payoff of 1 to the defender) and reopening bargaining, or to escalate to war at Node I, thus imposing the cost (–d) on the defender and incurring the cost (–c) himself. This will then lead to Node WRD where the defender may at last surrender to the demand x or decide to fight further. In the latter case, the challenger at Node WRC will decide whether to go through another round of war by continuing to fight, or to back down and thus reopen bargaining.

Costs and benefits will accumulate and bear interest whenever going through a "Time" move (following I or II). Thus, an eventual victory could be "Pyrrhic" if the accumulated and compounded costs exceed to value of holding the agreed upon share

forever. Once a division (x, 1-x) or (y, 1-y) in % has been agreed upon, it is valued at twenty times the share. For instance, if (22%, 78%) is the agreed outcome, the challenger's value is 22% of 20 or 4.4, while the defender's value is 78% of 20 or 15.6. From these results one should subtract the accumulated and compounded costs for a final score. Costs will accumulate interest at a rate of 5% each time a payoff state (I or II) is encountered. Costs will be fixed at the time of the simulation.[2]

The simulation will pair one student team against another. One team will be designated defender and the other challenger. Their respective costs (–c) and (–d) will be publicly announced at the time of the simulation. They will then play in turns until a bargain is finally accepted or until the game master calls for an end that would leave the defender holding the entire prize (for a value of 20 minus accumulated costs). Each team will be given a few minutes at its turn to make a decision. If no decision is made by the deadline, the gamemaster will implement default moves as follows: Demand x=1 at BRC, Resist at CRD, Backdown at CRC, Offer y=0 at BRD, Fight at WRD, and Backdown at WRC.

In this simulation there is no exogenous chance of one side winning outright such as winning a lawsuit or a decisive victory on the battlefield. Each participant will play once as a challenger and once as a defender, not necessarily against the same opponent. Each will then obtain a final score by adding the two scores obtained in each role. The highest scorer will be declared the winner.

A typical example of how the game could be played in illustrated in Table 1 below. The costs of fighting (c and d) are here assumed to be 5 units for each side. Initially, both sides' scores are zero. At the start, the challenger decides to demand x=90% (at Node BRC) rather than make a (polite) request or accept the status quo (y=0%) forever. This leads to Node CRD where the defender chooses to resist. Scores remain unchanged since no payoff state has been encountered. At the next node CRC the challenger decides to back down leading to the payoff node II. There, the defender receives a payoff of 1 unit corresponding to her still holding the whole prize. Time is now t=2.

At the next node BRD the defender decides to make a small offer y=10%. At BRC, the challenger turns down the offer but lowers his demand to 80%. At CRD the defender resists and at CRC the challenger escalates. This leads to the state of war where both sides incur the costs of 5 units. So, the challenger's score is now –5 while the defender's score is 1 plus 5% interest and minus 5 for a total of –3.95. Time is now t=3.

At the next node WRD the defender chooses to fight rather than surrender and the challenger backs down at WRC rather than incur another turn of war with its attendant costs. This leads back to Node II where the defender receives 1 unit of payoff and where prior scores bear interest. The challenger is now at –5 plus 5% interest (or –5.25) and the challenger is at –3.95 plus 5% interest (-4.15) plus 1, or –3.15. Time is now t=4.

At the next node BRD the defender decides to raise her offer to y=40% which the challenger accepts at BRC. The final scores are therefore:

40% of 20 minus 5.25=2.75 for the challenger;

[2] They will typically be in the range of 2 to 15.

60% of 20 minus 3.15=8.85 for the defender.

Time	State	Chal move	Def move	Chal score	Def score
t=1	BRC	Demand x=90%	-	0	0
	CRD	-	Resist	..	..
	CRC	Backdown	-	..	..
t=2	II	-	-	0	1
	BRD	-	y=10%	..	..
	BRC	Demand x=80%	-	..	..
	CRD	-	Resist	..	..
	CRC	Escalate	-	..	..
t=3	I	-	-	-5	1.05-5=-3.95
	WRD	-	Fight	..	..
	WRC	Backdown	-	..	..
t=4	II	-	-	-5.25	1-4.15=-3.15
	BRD	-	y=40%	..	..
Final	BRC	Accept	-	8-5.25 =2.75	12-3.15 =8.85

Table 1: A Typical Play of the Game