

22 February 2006. 5 March 2007. Eric Rasmusen, Erasmuse@indiana.edu.
[Http://www.rasmusen.org](http://www.rasmusen.org). Comments welcomed.

The War of Attrition Game

The Rules of the Game

Each firm consists of 3 students. Each year a firm must decide whether to stay in the industry or to exit. If it stays in, it incurs a fixed cost of 300 and a marginal cost of 2, and it chooses an integer price at which to sell (0,1,2,3,4,5,6,7,8,9, 10). The firms can lose unlimited amounts of money; they are backed by large corporations who will keep supplying them with capital indefinitely.

Demand is inelastic at 60 up to a threshold price of \$10/unit, above which the quantity demanded falls to zero.

Each firm writes down its price (or the word “EXIT”) on a piece of paper and gives it to the instructor. The instructor then writes the strategies of each firm on the blackboard (EXIT or price), and the firms charging the lowest price split the 60 consumers evenly.

The game then starts with a new year, but any firm that has exited is out permanently and cannot re-enter. The game continues until only one firm is active, in which case it is awarded a prize of \$2,000, the capitalized value of being a monopolist. This means the game can continue forever, in theory. The instructor may wish to cut it off at some point, however.

The game can then be restarted and continued for as long as class time permits.

Your Firm:

Your Names:

Year	No. of Firms	Price or EXIT	Winning Price	Revenue (0 or PQ)	Costs (0, 300, or $300+2Q$)	Current Profit	Cumulative Profit
1							
2							
3							
4							
5							

TABLE 1: SCORESHEET

No. of Firms is the number of firms that have not yet exited. Winning Price is the lowest price charged that year. If your firm exits in period n , it does not pay the fixed cost that period.

Cumulative Profit is the sum of the firm's profits in that industry up to and including that period and the prize of 2,000 if your firm is the survivor. It starts at zero again when only one firm is left in the industry and the game starts in a new industry.

Notes on the War of Attrition

There are several ways to vary the game. I suggest starting with a policy that firms cannot discuss strategies with each other.

The instructor may wish to halt the game temporarily after a few rounds and have public discussion.

The main point of the first play of the game will be that even the surviving firm might end up with a negative payoff, because the game may continue past 7 rounds.

Students at first may think this is the same as ordinary repeated oligopoly, and that their goal is to achieve collusion, which they know is difficult. If you next change the rules to allow discussion between firms, they will realize that collusion doesn't solve their problem.

This game will probably take 40 to 75 minutes. It is flexible because you can choose how many times to repeat it.

LESSONS:

1. In equilibrium, exiting or staying in have equal expected payoffs, if everyone is risk neutral. Staying in is riskier.
2. If you can convince your rivals that you are not going to exit, your payoff will be higher.
3. Profits are negative and price is near marginal cost until only one firm survives.
4. You might like to charge less than 2, just to inflict losses on your rivals. If you charge 2, you will earn zero profits (ignoring fixed costs). You might like to charge 1 or 0, though. The purpose would be to persuade your rivals that you will stay in forever, despite losses, because you are malicious, stupid, or insane (Nixon's "Madman Theory").
5. The game can go on more than the 7 periods which create a loss of 2,100, more than the value of the prize. Sunk costs are sunk.
6. This is like Shubik's "dollar auction", except you can get out for free at any time.
7. The only symmetric Nash Equilibria are in mixed strategies. There are lots of asymmetric Nash equilibria, however— for example, that Firm 1 stays in no matter what, but other firms exit immediately.
8. It does no good to collude. The colluding firms would just keep losing money. If two firms collude, for example, they would choose a price of 10, for revenues of $(10-2)(6) = 480$ excluding fixed costs. But their fixed costs would be $2*300=600$.
9. It is worth discussing what happens if some firms have limited budgets— that is, if they must exit after losing, say, 1,000. Those firms ought to exit immediately— if other firms are rational, the other firms will just wait them out.