An Introduction to Game Theory for Antitrust Lawyers©

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At least since *Matsushita*,[1] the difference between success and failure of arguments in antitrust cases has explicitly turned on whether the argument makes economic sense. The FTC's recent explication of the modern analysis of horizontal restraints shows both the importance of economic analysis to antitrust jurisprudence and the need for antitrust litigants to support their arguments with current economic learning.[2] Current economic learning includes more than just supply and demand, and plots of marginal cost and average variable cost curves. The modern economist's toolkit also includes a good bit of game theory, which has become, among other things, the standard explanation of how equilibriums are reached and the most persuasive way to explain behavior. Because of the importance of modern economic learning for antitrust argumentation, all antitrust lawyers ought to be familiar with at least a little game theory. This article explains several well known game theoretic tools that model decision-making, and shows how they apply to antitrust law and policy.

Every antitrust lawyer needs to be familiar with the basic vocabulary of game theory. The *players* are the decision-makers whose decision-making processes are modeled in the *game*. Each player has a set of *strategies* from which to choose, such as whether to enter a market, whether to price predatorily, whether to plead guilty to an antitrust crime. Each of these strategies has a certain *payoff*, which could be positive or negative, but represents the consequences of a particular strategy given the strategy of the other players or players. The difference between *cooperative* and *non-cooperative* games is that in a cooperative game, players can make binding commitments. For antitrust analysis, the most interesting games are non-cooperative; collusive agreements are illegal, and non-binding.

In any game, for any particular player, there is a set of strategies that are the *best responses*[3] for each of the possible strategies of the other player. For example, in the popular "rock-paper-scissors" game that children play, "rock" is the best strategy if the other player chooses "scissors," "paper" is the best strategy if the other player chooses "rock," and "scissors" is the best strategy if the other player chooses "paper." A combination of strategies is a *Nash equilibrium* if no player can improve his payoff by switching to a different strategy assuming that the other players do not change their chosen strategies.

I. The Chicago Chainstore Massacre

Under the influence of the Chicago School, courts, including the Supreme Court, have become extremely suspicious of plaintiffs' claims of predatory pricing. Economic theory, according to the Chicago view, leads to the conclusion that predatory pricing is implausible and irrational.[4]

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[1] Matsushita Elec. Indus. Co. v. Zenith Radio Corp., 475 U.S. 574, 587 (1986). Economic plausibility was part of the Supreme Court's antitrust jurisprudence at least as early as 1911, but economic analysis in the early cases was sometimes implicit. *See, e.g.*, Standard Oil Co. v. United States, 221 U.S. 1 (1911).

[2] In the Matter of Polygram Holding, Inc., 2003 WL 21770765, Dkt. No. 9298 (FTC July 24, 2003).

[3] The term "response" is not intended to imply that a player choosing a response makes that choice only after the other player has made his choice. In many models choices must be made simultaneously without the knowledge of what another player's choice was or will be.

[4] *See, e.g.*, Frank H. Easterbrook, *Predatory Strategies & Counterstrategies*, 48 U. CHIC. L. REV. 263 (1981).

Game theory allows antitrust lawyers to be a bit more sophisticated. Consider an incumbent store that is the monopolist in the relevant geographic market because it is the only store in the market. Suppose its monopoly rents are 200, and suppose that if a new store were to enter the market, the duopoly rents would be 100, which the two stores would split evenly if the incumbent declined to engage in a price war. If the incumbent engaged in a price war, prices would fall to the competitive level, and, therefore, monopoly rents would be zero. But competing prices down to marginal cost would not deter entry because marginal cost includes return to capital invested (or the marginal cost of not investing in the next best activity). So to deter entry, the incumbent would have to price below cost, forcing both itself and the entrant to incur losses of 10. We can diagram this game in what game theoreticians call "the extensive form," as shown in Figure 1.[5] The Chicago School conclusion is that it is irrational for the incumbent to price below cost because its return would be lower, even lower than if it competed until price equaled marginal cost. The response that an incumbent could use profits in other markets to support the below-cost pricing until the entrant leaves is met with the Chicago rejoinder that increasing prices in other markets, or later periods in the same market, would simply encourage entry in those markets as well.

The "entry deterrence" game modeled in Figure 1 supports this conclusion until one realizes

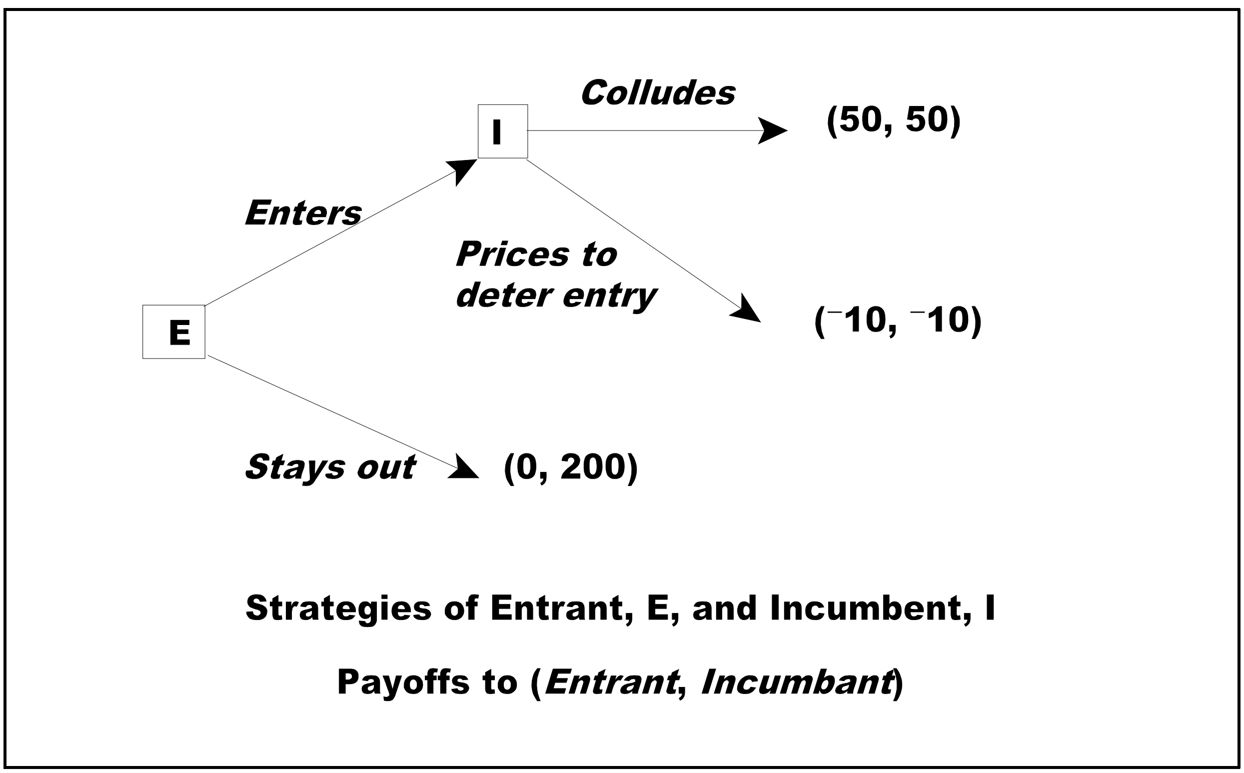

Figure 1

[5] This model is adapted from Reinhard Selten, *The Chain Store Paradox*, 9 THEORY & DECISION 127 (1978), and ERIC RASMUSSEN, GAMES & INFORMATION 94 (3d ed. 2001).

that although the entrant may be playing the game only once, the incumbent is playing it repeatedly, in each of its markets and in each of the time periods during which a new rival might enter. In the one-shot (unrepeated) version of the game, the entrant must first decide whether to enter or stay out. If it stays out, it gains nothing but loses nothing; if it enters, the incumbent will have to decide how to respond. If the incumbent priced to deter entry, it would lose money, because entry has already occurred; the incumbent's best strategy, therefore, is to adopt duopoly pricing, still reaping supracompetitive profits of 50. Faced instead, however, with a series of iterations of the game, an incumbent in more than one market facing possible entrants in many future time periods knows that its payoff is not from a single game, but the sum of payoffs of a series of games. This incumbent might find it profitable to deter entry in later iterations by pricing below cost in the first iteration. In game theoretic terms, if it makes its threat to price below cost *credible*, the incumbent can signal to possible rivals in other markets that they will indeed lose money if they try to enter. Thus, although the incumbent might lose 10 in the first iteration of the game, it will increase the likelihood that it will reap profits of 200 in each subsequent iteration of the game.

How credible is this threat? In his path breaking article "The Chain Store Paradox,"[6] future Nobel laureate Reinhard Selten showed that if there is a finite number of iterations of the entry deterrence game, the threat to punish the entrant is never credible. Selten argued that we must reason backward, using a technique now known as backward induction. Assume there are twenty relevant markets, and flash forward to the twentieth iteration of the game: the incumbent and the entrant are now facing the game modeled in Figure 1 as a single, unrepeated game. In this iteration, below-cost pricing would be irrational, because it would result in lower profits to the incumbent. Thus, entrant number 20 knows that incumbent will not price below cost in market number 20. Knowing this result for market number 20, the entrant in market 19 undertakes the same analysis. Once again, the only rational (profitable) choice for the incumbent is not to price below cost in market 19. Working backward through all eighteen remaining markets, game theory seems to confirm the insight of the Chicago School.

But what if there are an unlimited number of markets and an infinite time horizon? In such a case, there would be no final iteration of the game from which to work backward. An incumbent facing a sufficiently long time horizon and a sufficiently large number of markets will conclude that the strategy that maximizes profits is one that early shows that its threat to price below costs is credible so that it can reap monopoly profits in other markets and later periods. Thus, game theory tells us, for example, that the rational strategy for a large, successful airline during a period of expansion of hubs and routes and growth in demand for air travel might be quite different from the strategy of an airline struggling through bankruptcy during the post-September 11th contraction of the industry.[7] And a rational strategy for any incumbent, moreover, might be to price predatorily in early iterations as a means to signal to rational entrants that the incumbent is irrational enough to lose money, thereby discouraging entry by making the threat of predation credible.[8]

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[6] Selten, *supra* note 5.

[7] *See* United States v. AMR Corp., 335 F.3d 1109, 1114–15 (10th Cir. 2003) (discussing, without deciding, the issue of whether the Chicago School approach to predatory pricing is persuasive).

[8] David M. Kreps & R. Wilson, *Reputation and Imperfect Information*, 27 J. ECON. THEORY 253 (1982).

II. Go Directly to Jail? The Prisoner's Dilemma and Antitrust Crimes[9]

Perhaps the game theoretic tool most familiar to non-economists is the Prisoner's Dilemma. Two co-conspirators are in police custody, questioned separately. Each faces two choices: he may confess, assist in the prosecution of the co-conspirator and accept a lenient sentence or litigate the case, facing a significant prison term if his co-conspirator confesses and assists the prosecution, but only a short prison term if both refuse to confess because without such cooperation the government can only prove a lesser charge. Because of the significant fines that can be imposed under the Sherman Act[10] and the alternative fine provision of Section 3571(d),[11] and the Antitrust Division's Leniency Policy,[12] this dilemma is one that many antitrust lawyers and their clients have faced. Assume that there are two similar companies each of whose volume of affected commerce was $250 million and that the corporations were large and high level executives were involved in a suspected criminal cartel. The criminal fine if either of the two corporate conspirators were convicted would likely be $150 million; if one of the conspirators reports the conduct to the government and cooperates with the government, it will receive amnesty; if both cooperate more or less simultaneously, the cooperation is not as valuable because it is not essential to the conviction of another defendant, and so each defendant will be fined $75 million; if both litigate the case, each can expect to pay a fine of, say, $15 million, assuming at this early stage of litigation the chance of conviction is only 0.1.[13] The decision-making process modeled in this game is usually represented by the following table, using what game theoreticians refer to as "strategic form."

Figure 2: Prisoner's Dilemma

	D_2 denies guilt and litigates	**D_2 assists prosecution**
D_1 denies guilt and litigates	D_1 pays $15 million; D_2 pays $15 million	D_1 pays $150 million; D_2 pays 0
D_1 assists prosecution	D_1 pays 0; D_2 pays $150 million	D_1 pays $75 million; D_2 pays $75 million

Game theoretic analysis requires us to ask what is the best strategy for a particular player given each of the other player's strategies. Here, if D_2 litigates, D_1's best strategy is to assist the

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[9] This section is adapted from Phillip C. Zane, *The Price Fixer's Dilemma: Applying Game Theory to the Decision of Whether to Plead Guilty to Antitrust Crimes*, 48 ANTITRUST BULL. 1 (2003), which provides a more complete explanation of the principles at work and the calculation of the criminal and civil liabilities.

[10] Up to $100 million. 15 U.S.C. § 1.

[11] Up to twice the gain to the defendant or twice the loss to the victim. 18 U.S.C. § 3571(d). The constitutionality of this provision in cases involving economic crimes has been questioned. Phillip C. Zane, *Booker Unbound: How the New Sixth Amendment Jurisprudence Affects Deterring and Punishing Major Financial Crimes and What to Do About It*, 17 FED. SENTENCING REP. 263 (2005); ANTITRUST MODERNIZATION COMMISSION, REPORT & RECOMMENDATIONS 299 (2007).

[12] U.S. Dep't of Justice, Antitrust Div., Corporate Leniency Policy (August 19, 1993).

[13] The probability itself does not matter for this part of the analysis as long as it is less than 1.0. For more details on how the values in the table can be estimated, see Zane, *supra* note 9.

prosecution because paying zero is better than paying \$15 million. Similarly, if D_2 assists the prosecution, D_1's best strategy is, once again, to assist the prosecution because paying \$75 million is better than paying \$150 million. Thus, regardless of what D_2 does, D_1's best strategy is to assist the prosecution. In game theoretic terms, this game has a single Nash equilibrium, and D_1's best strategy is a pure strategy of always assisting the prosecution.

The result of this analysis, of course, could be a rush to the Antitrust Division's door at the first whiff of antitrust scandal, which, of course, is what the Division wants the members of the antitrust defense bar to do. But, again using game theory, the defense bar must be much more sophisticated: both the corporation convicted of a price fixing conspiracy and the one that received leniency and assisted in the conviction of its co-conspirator, will surely face civil actions for treble damages, and, because of the prima facie evidence rule of the Clayton Act, liability in the civil case will be automatic.[14] The sophisticated antitrust lawyer knows the client is facing not just the criminal prosecution, but also one or more civil lawsuits where the plaintiffs will be seeking treble damages, that is, three time the difference between the price charged and what the price would have been had there not been a conspiracy. The strategic choices of each of the two conspirators are (1) litigate both cases, (2) litigate the criminal case and settle the civil case early, (3) settle the criminal case and litigate the civil case, and (4) settle both cases early. Assuming that 10% of the price of the goods sold represented the overcharge, each defendant faces a possible civil judgment of \$75 million in the case brought by direct purchasers; because of joint and several liability, each could owe up to a total of \$150 million. Any award would also include, of course, attorneys' fees, which we can leave out of the simplified model we are building here.

Assuming that a finding of liability in the civil case is twice the likelihood of conviction in the criminal case, reflecting the lower standard of proof in civil cases, the expected liability if the civil case is litigated is 0.2 times the measure of damages, or \$15 million. But remember that if the criminal case is settled, liability in the civil case is certain, and, here, certainly \$75 million. On the other hand, if one of the defendants settles the civil case, it can probably settle for a figure high enough to cover single damages (because it has to be high enough that a judge will approve it if the case, as it probably is, is a class action), but discounted from full treble damages to reflect the probability that the defendant will win the case. Of course the non-settling defendant will owe the balance of both defendants' treble damages. Making some reasonable assumptions about settlement, we can construct the following table, showing the total liability for each defendant for the criminal and civil cases combined, for each of the possible strategic choices available early in the case:

[14] 15 U.S.C. § 16(a). Note that the rule permitting nonmutual offensive collateral estoppel of *Parklane Hosiery Co. v. Shore*, 439 U.S. 322 (1979), would also apply, and also result in automatic liability.

Figure 3: The Price Fixer's Dilemma:
Criminal and Direct Purchaser's Civil Case
Sums of Fines and Judgments Paid by D_1 and D_2

		D_2's Strategies criminal case plus civil case			
		litigate, litigate	*litigate, settle*	*settle, litigate*	*settle, settle*
D_1's Strategies criminal case plus civil case	*litigate, litigate*	30, 30	130, 50	225, 75	226, 74
	litigate, settle	50, 130	90, 90	224, 76	225, 75
	settle, litigate	75, 225	76, 224	150, 150	151, 149
	settle, settle	74, 226	75, 225	149, 151	150, 150

Working through the table we can identify D_1's best strategies. If D_2 litigates both cases, D_1's lowest liability is where it also litigates both cases; for all of D_2's other strategies, D_1 does best if it settles both cases. D_1's best strategy is, therefore, not the pure strategy of Figure 2, but the "mixed" strategy of litigating both cases if D_2 is likely to litigate both cases, and settling both cases if D_2 is more likely to follow any of the other strategies. So what should D_1 do? Note, of course, that both defendants pay less if they both litigate both cases. Experiments offering analogous choices outside the antitrust context have shown that when facing this type of choice, the best strategy is to choose the pareto-optimal strategy, the strategy equivalent to litigating both cases in the present model, until and unless the other player (defendant) chooses the strategy equivalent to settling both cases.[15] Whether this translates to the antitrust context is more difficult to test. It is noteworthy, however, that several of the companies involved in the high profile international cartel investigations have been involved in, or have been accused of having been involved in, more than one conspiracy. It is incumbent upon antitrust counsel, therefore, to conduct thorough internal investigations, to put a stop to criminal activity if it is ongoing, to assess what the civil damages might be, and to ascertain just how likely it is that criminal violations will be discovered and proved.

The lesson for antitrust policy-makers is also clear. If encouraging self-reporting of antitrust crimes is an important goal, as senior officials of the Antitrust Division have insisted, then policy-makers must recognize that this game-theoretic analysis shows that the certainty of massive liability in civil cases following criminal antitrust convictions discourages corporations from self-reporting antitrust crimes. Eliminating liability for treble damages for corporations that have received leniency would go a long way toward reducing this disincentive, which is just what Congress recently did.[16]

[15] *See, e.g.*, ROBERT AXELROD, THE EVOLUTION OF COOPERATION (1984).

[16] Pub. L. 108-237, §§ 211–214, 118 Stat. 666 (June 22, 2004). This provision sunsets in 2009.

III. Get Out of Jail Free? Oligopolistic Pricing without Communication, Or Game Theory as a Non-Plus Factor.

The problem of what quantity of goods to produce led to Cournot's model of duopolistic competition, which may be the oldest description of a game theoretic model and in many ways anticipated some of Nash's insights.[17] The Cournot model is usually presented in mathematical terms because the strategic choices are infinite, but it can be roughly depicted as a kind of Prisoner's Dilemma.[18] Two identical firms, F_1 and F_2, are the only firms producing widgets. Remember that the laws of supply and demand dictate that as the total quantity produced increases, the price paid falls. Thus the firms want to produce enough to maximize profits, but not so much that profits fall. For the sake of simplicity, we will limit their choices to two levels of output which we know to be (see note 18) the profit maximizing levels for a competitive market, 300,000 widgets, and for a monopolistic or collusive market, 225,000 widgets. This is presented in Figure 4.

Figure 4: Simplified Cournot Duopoly

	F_2 produces 225,000	**F_2 produces 300,000**
F_1 produces 225,000	F_1 receives $101,250; F_2 receives $101,250	F_1 receives $84,375; F_2 receives $112,500
F_1 produces 300,000	F_1 receives $112,500; F_2 receives $84,375	F_1 receives $90,000; F_2 receives $90,000

Examining this game, we see that if F_2 produces 225,000 widgets, F_1 maximizes profits by producing 300,000 widgets and earning profits of $112,500. Similarly, if F_2 produces 300,000 widgets, F_1 once again maximizes profits by producing 300,000 widgets and earning profits of $90,000. Just as in the one-shot prisoner's dilemma of Figure 2, there is a single Nash equilibrium, yet, once again, both firms would be better off if they had agreed to make a different choice, and if that agreement were somehow enforceable. The Sherman Act, of course, prohibits such agreements,

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[17] AUGUSTIN A. COURNOT, RESEARCHES INTO THE MATHEMATICAL PRINCIPLES OF THE THEORY OF WEALTH 79–89 (1971 repr. of 1897 trans. of 1838 French ed.); John F. Nash, Jr., *Equilibrium Points in n-Person Games*, 36 PROCEEDINGS OF THE NAT'L ACADEMY OF SCIENCES 48 (1950). For a more detailed discussion of the Cournot model, see ROBERT GIBBONS, GAME THEORY FOR APPLIED ECONOMISTS 144–146.

[18] This model is based on JOEL WATSON, STRATEGY: AN INTRODUCTION TO GAME THEORY 95–97 (2002), which properly describes the model in terms of a price function, $p = 1000 - q_1 - q_2$, where q_1 and q_2 are the outputs in thousands of two identical firms, 1 and 2, who face identical costs of $100 per thousand units of output. Firm 1's profit is determined by the utility function, $u_1(q_1, q_2) = (1000 - q_1 - q_2)q_1 - 100\, q_1$. Taking the partial derivative of u_1 with respect to q_1 gives us firm 1's best response function of $q_1 = 450 - q_2/2$. Firm 2 has a similar best response function, and the values for q_1 and q_2 that simultaneously solve both functions are 300 and 300. If we expressed the functions in terms of Q, that is for a single, combined firm or for the industry as a whole, the utility function would be $U(Q) = (1000 - Q)Q - 100Q$. Taking the derivative of this, we have $dU/dQ = 1000 - 2Q - 100$. Thus, the industry maximizes profits where $0 = 1000 - 2Q - 100$, that is, where $Q = 450$. Since the firms are symmetrical, each maximizes collusive profits when each produces 225. The matrix in the text presents the strategic choices as between the profit-maximizing competitive output and the profit-maximizing collusive output and the figures chosen are reached by solving the equations set out in this note.

and this model shows why: if the firms compete, the consumer gets more and pays less. But, once again, firms are not playing one-shot games: they continue to produce, in period after period.

Suppose now that a firm's choices are not simply whether to produce at the monopolistic level or the competitive level in this period, but whether to follow a multi-period strategy designed to reward the other player's choice of output if that output is set at the monopolistic level, and to punish the other player's choice if the output is set at competitive levels.[19] On at least a theoretical level, there exists a multi-period Nash equilibrium where a firm produces at some level below the competitive level until and unless the other firm produces at or closer to the competitive level, after which point the first firm will produce at the competitive level forever.[20] The complexity of the matrix depicting strategies and payoffs depends on the time horizon: considering just two periods requires a matrix with sixteen combinations, as in Figure 3; considering three periods requires sixty-four combinations.

Plainly the best payoffs for both players would be obtained if both produced at the monopolistic level forever, but the temptation to deviate from this to reap the short-term benefits of producing at a higher level while the other firm produces at the monopolistic level must surely be great. A famous experiment solicited strategies from leading game theoreticians for a Prisoner's Dilemma whose payoffs were analogous to those in Figure 4 and that continued for 200 rounds. The best strategies were those that started by colluding (tacitly, of course), and only competing in certain conditions; the very best strategy was the one known as "tit-for-tat," which colluded in the first round and punished the non-colluding player by responding to competition in one round by competing in the immediately subsequent round.[21] Thus, from a game-theoretic perspective, a plausible outcome of *independent* decisions on output is supracompetitive output and prices that resemble the levels that would be reached from explicit and illegal collusion. In other words, independent decision-making will not necessarily result in driving prices toward marginal cost. And such tacit collusion cannot be illegal under the Sherman Act, which forbids, of course, only a "contract, combination or conspiracy" in restraint of trade.

The applicability of game theory to the both the defense and prosecution of oligopolistic pricing is clear and its implications profound: Game theory provides an economic justification for independent but identical, even lock-step, changes in price that should not be condemned by the Sherman Act without evidence of actual collusion.[22] But game theory also suggests that the threshold showing of "plus factors" necessary to conclude that conscious parallelism was in fact the result of actual collusion ought perhaps to be lower than it is.[23]

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[19] *See* HERBERT GINTIS, GAME THEORY EVOLVING 121–126 (2000).

[20] GINTIS, *supra* note 19, at 122–23 (proving the existence of this equilibrium point where produces set price, not output).

[21] AXELROD, *supra* note 15.

[22] *Contra, e.g.*, American Tobacco Co. v. United States, 328 U.S. 781 (1946).

[23] Blomkest Fertilizer, Inc. v. Potash Corp. of Saskatchewan, 203 F.3d 1028 (8th Cir.) (en banc), *cert. denied sub nom.* Hahnaman Albrecht, Inc. v. Potash Corp. of Saskatchewan, 531 U.S. 815 (2000).

IV. The Bug in Your Operating System is a Centipede

Research on backward induction and the Chain-Store Paradox led to the development of the Centipede Game,[24] so called because the extensive form of the game resembles a centipede. Figure 5 illustrates such a game. The game begins on the left. A player has two moves, "Across" or "Down." Choosing "Across" continues the game to the next move; choosing "Down" ends the game and the players receive the payoffs indicated. This type of game can be useful in modeling negotiations, where "Down" can represent accepting the pending the offer (or terminating negotiations), and "Across" can represent the next round of negotiations.

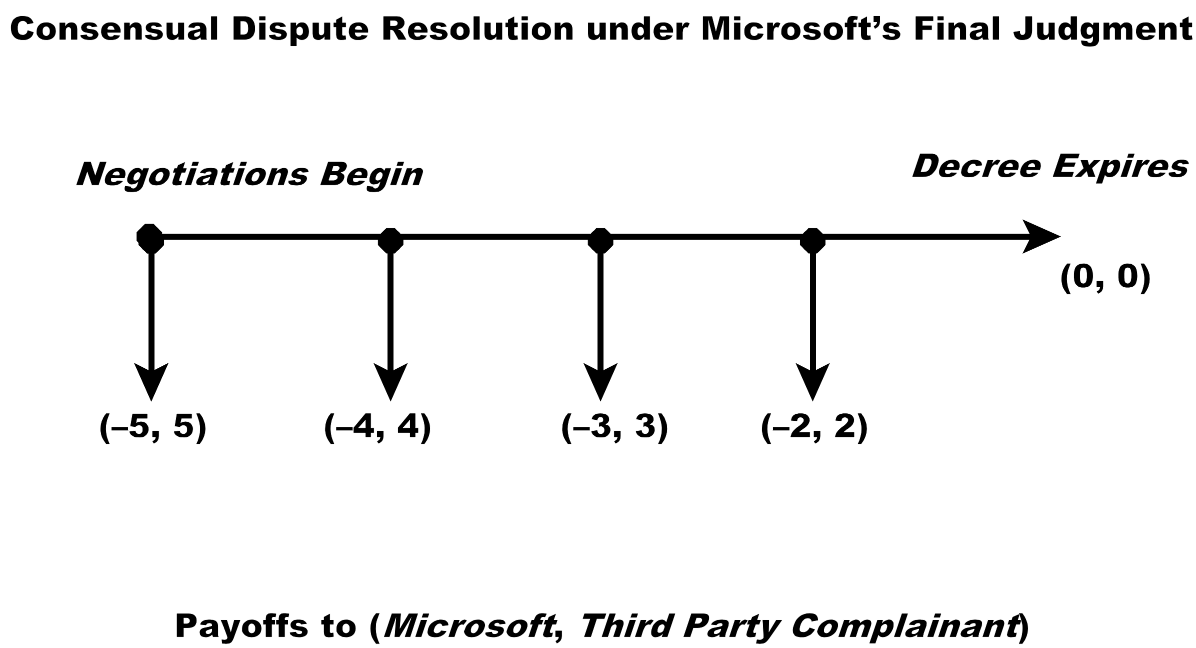

Figure 5

[24] Robert W. Rosenthal, *Games of Perfect Information, Predatory Pricing and the Chain-Store Paradox,* 25 J. ECON. THEORY 92 (1981). The Chain Store game presented in Section I is also a centipede game.

One of the enforcement mechanisms of the Final Judgment in *United States v. Microsoft Corp.*,[25] allows third parties to submit complaints to Microsoft's Technical Committee, which may then investigate and, if the complaint is meritorious, propose a cure. Unless the U.S. Government gets involved and shows that Microsoft is in contempt of the decree, however, there is no mechanism that forces Microsoft to accept a cure proposed by the Technical Committee or a third party. The decree runs for five years and then expires. Suppose a third party has a meritorious complaint, and suppose the Technical Committee and the third party propose a cure. Assume the cure imposes some cost on Microsoft, say a payoff of –5, and will bring some benefit to the third party, say a payoff of 5. As modeled in Figure 5, Microsoft may accept the cure, or refuse it, continuing the negotiation. For the negotiations to continue, the third parties' next offer will not be quite as onerous on Microsoft, and not quite as beneficial to itself. Moving from leg to leg of the centipede, we see the payoffs to Microsoft improving (here, of course, getting less bad), and the payoffs to the third party worsening. Because the time-horizon is so short, Microsoft has no incentive to end the game at any negative payoff because it knows, first, the next offer will be better, and, second, if it can string out negotiations long enough, the judgment will expire and it will not have to do anything to accommodate the third party. Thus, consent decrees with behavioral remedies appear to be unlikely to affect behavior unless the decree includes enforcement provisions allowing an impartial decision-maker to force the defendant to address meritorious complaints.

Conclusion

The power of a game theoretic model to explain and predict behavior depends on how well it captures the most important facts of the decision-making process. At times game theory confirms explanations offered and results predicted by neo-classical economics, and at times it refutes or refines those results. A slight change in the rules of the game, for example, from a finite number of iterations to an infinite number, can significantly change the result. Thus the rules must match the relevant facts of the decision-making process being modeled. Moreover, game theory does not stop at mere theory. It has given rise to the field of experimental economics, which gives researchers the chance to test theories of behavior in ways economists and other social scientists could not do before. All this means that when an antitrust lawyer, as counsel for plaintiff, defendant, or prosecution, or for proponent or opponent of a merger, considers the economic theory underlying the merits of a claim or defense, the client is best served if game theory is one of the analytical tools at counsel's disposal.

[25] United States v. Microsoft Corp., Civ. No. 98-1231 (CKK) (Final Judgment, Nov. 12, 2002).