BUSINESS STRATEGY

Business strategy derives optimal managerial decisions when other firms (or persons) possibly change their behavior in response to your behavior. In the last section we learned that demand for a firm's product depends on what competitors charge. But the competitor's price was held fixed. We did not consider that if we change our price, competitors will likely match our price change. In order to really assess the value of, say, cutting prices, we need to consider what others will do in response to our actions. A critical calculation that is often overlooked in business situations is how other firms will react. Business strategy determines optimal managerial decisions when other firms and persons change behavior in response to your decisions.

I Framework: Two Person Games

Here we suppose only one other player, but the other player could be another firm, another person, or "the industry."

A Payoff matrix

The payoff matrix lists all rewards that each player gets as a function of decisions made by all players. Consider a "price war" game. Firm A (you) and Firm B are the dominant firms in the industry. Because of antitrust laws, you are forbidden from colluding with B to raise prices or even from discussing prices. You know that if you cut prices and Firm B does not, you can take the majority of the market share and make a large profit, say \$6 million, while Firm B loses \$1 million. The reverse is also true, if Firm B cuts prices and you do not, then Firm B gains market share and makes \$4 million and Firm A makes \$1 million. However, if both firms cut prices, profits are zero for both firms. Finally if both firms do not cut prices, the market is split between the two firms, but the relatively high prices allows each firm to make a profit of \$3 million.

		Firm B	
		Hold prices	Cut prices
Firm A	Hold prices	3,3	1,4
	Cut prices	6,-1	0,0

Notice that the first number is always the payoff of the firm listed on the left (rows), whereas the second number is the payoff of the firm listed on top (columns).

B Dominant Strategy

If your best action is independent of what the other player does, then the decision is easy.

Definition 26 *A* **Dominant Strategy** *is an action that is at least as good as all other actions regardless what the opposing player chooses.*

Let us look at the above game. Suppose Firm B elects to hold prices. Then it is in the best interest of Firm A to cut prices and steal Firm B's customers (since $6 Million is greater than $3 Million). However, if Firm B elects to cut prices, then it is in the best interest of Firm A to hold prices. Firm A will lose most customers, but make $1 million on the remaining customers (if Firm A cuts prices, Firm A makes nothing). Thus Firm A does not have a dominant strategy: the optimal decision depends on what Firm B does. However, Firm B does have a dominant strategy. If Firm A holds prices, Firm B should cut prices and steal business away from Firm A. If Firm A cuts prices, then Firm B does better by cutting prices, splitting the market and making no profit is better than losing $1 million. So the dominant strategy of cutting prices generates the highest possible profits for Firm B regardless of the actions of Firm A.

C Nash Equilibrium

We need a way to compute the optimal strategy when no dominant strategy exists for at least one of the players. The trick is to predict the behavior of the other firm. In the above example, Firm A might predict that Firm B will cut prices. After all, cutting prices is the dominant strategy for Firm B, regardless of what Firm A does. Once Firm A predicts what

Firm B will do, then Firm A needs to compute the optimal strategy. Given that Firm B will cut prices, Firm A should hold prices. Now the last step is to check if our prediction is accurate: if Firm A holds prices then Firm B will certainly do better by cutting prices, so our prediction that Firm B will cut prices is correct. Therefore the optimal strategy for Firm A is to hold prices and the optimal strategy for Firm B is to cut prices. Together, these strategies are what we expect to see in equilibrium.

Let's see if cutting prices can be an optimal strategy. Suppose Firm A cuts prices. Then Firm B responds by cutting prices. But then it is no longer optimal for Firm A to cut prices: Firm A does better by holding prices. So cutting prices is not an equilibrium strategy for Firm A, since they will regret their decision if Firm B acts in an optimal way.

Definition 27 *A* **Nash Equilibrium** *is a set of strategies such that each player accurately believes that he/she is acting optimally given the strategy of the other players.*

The Nash Equilibrium is conditional on what other players do. By assuming the other player will act optimally and accurately predict what you are doing, you can predict what the other player will do.

Let's get some insight into what is happening. Firm A, perhaps a dominant firm with loyal customers, has certain advantages. Firm A does as well as Firm B when both firms use the same strategy. However, when Firm A is undercut by B, Firm A makes more profits than Firm B would in the reverse case. This actually works against Firm A, however. Firm B knows that Firm A will not match B's price cut, since Firm A does better by ignoring Firm B and just making money from its loyal customers. Therefore, Firm B can make inroads into Firm A's business by offering goods at low prices. Firm A is then forced into one of the worst possible outcomes. One would think that Firm A, a big firm, could threaten to cut prices and try to intimidate B into holding prices. But such a threat is not credible.

Let's try another example.

		Firm B	
		Hold prices	Cut prices
Firm A	Hold prices	3,3	1,4
	Cut prices	5,0	0,0

Here we have slightly altered the payoffs that occur when Firm A cuts prices and when Firm B holds prices. The previous Nash equilibrium continues to hold: If Firm B predicts Firm A holds, then Firm B does at least as good by cutting, in which case Firm A should hold. So Firm A holds and Firm B cuts continues to be an equilibrium. Now suppose Firm B preditcs Firm A cuts. Then Firm B does at least as well by holding, in which case Firm A should cut. Therefore the set of strategies Firm A cuts and Firm B holds is also a Nash Equilibrium. Often more than one Nash Equilibrium exists, in which case the behavior gets harder to predict. Consider the "coordination" game of which side of the road to drive on.

Car B

		B's Left Side	B's Right Side
Car A	A's Left Side	10,10	-5,-5
	A's Right Side	-5,-5	10,10

If both drivers drive on the opposite sides of the road (from their own perspective), it is disaster for both players. But it does not matter if both players drive on their right or left. Therefore, two Nash Equilibria exist, and we should be able to observe that in some countries people drive on the left and in other countries on the right.

II Some Simple Games

A Anti-Coordination Games: to compete or not?

Suppose firms need to decide which markets to target. ATT and Sprint can target cell phones or conventional land lines via advertising and investing in towers and satellites in the case of cell phones, or conventional cables in the case of land lines. If both firms invest in the same business, competition will be fierce and each company will price close to marginal cost, which is low relative to the high fixed costs of the towers and cable. However, if each focuses on a different market, both will make money by charging more:

Sprint

		Cell Phones	Land Lines
ATT	Cell Phones	0,0	5,2
	Land Lines	2,5	0,0

So two Nash Equilibria exist, one with ATT specializing in land lines and Sprint cell phones, and vice versa. Notice that whoever gets the cell phone business is better off since the cell business makes profits equal to 5. This can make the outcome somewhat uneasy: both firms, deciding together, may choose cell phones and then hope the other firm chooses land lines. Or if the game is not perfectly simultaneous, both firms may rush into the cell phone business in the hopes that competitors will be deterred from doing so.

B Coordination Games

Clearly, if the firms sell complementary goods, such as cameras and film developing centers, the incentives are to locate together.

C Mixed Coordination and Anti-Coordination

Let's try a tougher one of store location.

		Target			
		Uptown	Center City	East Side	West Side
Macy	Uptown	30,40	50,95	55,95	55,120
	Center City	115,40	100,100	130,85	120,95
	East Side	125,45	95,65	60,40	115,120
	West Side	105,50	75,75	95,95	35,55

Both firms would like to locate in the relatively wealthy Center City, due to the high incomes (and the ease of shopping while at Center City for work). In addition, if both stores locate together, they could possibly draw larger crowds by establishing the area as a place to shop. Macy is a more upscale place, however, and does better than Target in the high income areas (such as the East side). Target has low prices and does better than Macy's in the low income areas, but still does better in the high income areas than the low income areas. So the Nash equilibria (I'll leave it to you to check) is for both stores to locate at Center City and compete: the extra income of Center City outweighs the losses from competing.

Let's try another one. Let's suppose Dave, Deana, and Jack are brokers trying to pick the latest hot stock. The stock may go up or down, no one really knows. If an advisor picks correctly, they are rewarded with more business. If advisors are incorrect, they lose business. Further, if an advisor recommends buy while the others recommend sell and the stock goes up, the advisor gets a lot of new business. But suppose the reverse is worse, if the advisor recommends buy when everyone else is recommending sell and the stock goes down, the advisor loses a lot of business. Here are the payoffs:

Jack Pick's Buy

Dave

Deana		Buy	Sell
	Buy	5,5,5	6,4,6
	Sell	4,6,6	6,6,4

Jack Pick's Sell

Dave

Deana		Buy	Sell
	Buy	6,6,4	4,6,6
	Sell	6,4,6	5,5,5

Pick any two players, say Jack and Deana. If Dave predicts Jack and Deana pick buy, then Dave is better off picking buy. Similarly, if Jack and Dave pick buy, Deana should recommend buy. Similarly, if Deana and Dave pick buy, Jack should pick buy. The same is true for sell. So two Nash Equilibria exist, one where all players pick buy and the other where all players pick sell. A rule I use in life: when asking an opinion of someone, never let them know what others have said.

Advantages of coordinating or not coordinating.

1. Coordinate by locating near competitors to draw shoppers to the area.
2. Coordinate by locating near competitors if demand (even with two competitors) in the area is better than other areas.
3. Coordinate if differentiating your product and being wrong about customer preferences yields more losses than the gains from being right about customer preferences.
4. Coordinate only if incumbant firms will not react forcefully to your entry.

D Prisoners Dilemmas

Suppose a symmetric version of the price war game:

Firm B

Firm A		Hold prices	Cut prices
	Hold prices	3,3	0,5
	Cut prices	5,0	1,1

So here a unique Nash Equilibrium exists where both firms cut prices (a price war ensues). Notice a peculiar feature of this game. We can think of the "social maximum" as the set of strategies that benefits all players (with, say, equal weight) the most. So the upper left corner has a social benefit (SB) to the two firms (obviously not to the consumers) of $SB = 3+3 = 6$. Similarly:

Firm B

Firm A		Hold prices	Cut prices
	Hold prices	$SB = 6$	$SB = 5$
	Cut prices	$SB = 5$	$SB = 2$

So the Nash Equilibrium is the worst possible outcome for the two firms! In fact, if firms could only collude on prices, they would surely agree to both hold prices high. The prisoners dilemma is the basis for antitrust rules prohibiting price collusion and is perhaps the most important game in business. By prohibiting collusion or discussion of prices, the market keeps intact the incentive to cut prices (benefiting consumers).

1 Cartels and Cheating

Of course, in reality, prisoner's dilemmas are not always fully non-cooperative (meaning each player moves simultaneously without knowledge of the other's move). Some degree of information sharing about prices is always possible, and firms can sometimes agree to form a cartel and not cut prices. However, the incentive to cheat on such an agreement is very strong. If you know the other firm is sticking to the agreement and keeping prices high, you have a strong incentive to cut prices.

2 Price Matching Offers

Why do Firms offer to match prices of other firms and do these offers benefit consumers? I was negotiating with a car dealer about a year ago. We had reached a sticky point in the negotiations and I said that I could get the car for less elsewhere. He responded all of the dealers in the area had agreed not to sell for less than this price (a bold admission of illegal price fixing!). I then said I was holding an offer from someone else for less. He said immediately to bring the offer in and he would match it (a price match clause, common among retailers). Let us see how the payoffs change. Now if one firm cuts prices, the other firm automatically matches and the gain from cheating is erased:

		Firm B	
		Hold and match prices	Cut prices
Firm A	Hold and match prices	3,3	1,1
	Cut prices	1,1	1,1

Now two Nash Equilibria exist, one in which the cartel continues to hold and the other which has both firms cutting prices. But it is clear that a cartel agreement will not suffer from cheating, as in the prisoners dilemma. If the firms form a cartel and agree to not to cut prices, the cartel will not breakdown because neither firm has an incentive to lower prices. Thus price-matching agreements are known to be instruments of price fixing, rather than benefiting consumers.

Prisoners dilemmas are more complex when played more than once. We will look at this in Section 4.

III Mixed Strategies

Some games have no Nash Equilibrium. When each player has an interest in disguising their actions, it is often optimal to choose a random or mixed strategy.

A Using Mixed Strategies to Prevent Opponents From Reacting

Consider the "Blue Light Special Sale." The seller wants to get rid of excess inventory. But if the seller announces a sale on a specific date, then all customers would shop on that date only, including those who would have bought the product at the high price. What would be ideal is if non price sensitive customers did not change their behavior in response to when the sale was.

		Customer	
		Shop today	Shop tomorrow
Firm	Sale today	5,10	8,4
	Sale Tomorrow	10,5	4,8

The customer (lets say this customer would buy at full price) is better off shopping on the day when the sale is. The firm is better off if this customer comes on a day when there is no sale. No Nash Equilibrium exists in this game. Suppose the firm predicts customers will shop today. Then the firm chooses to have the sale tommorrow. But then after announcing the sale, customers will shop tommorrow, so customers shopping today is not a Nash Equilibrium. Similarly, if the firm predicts shoppers will shop tommorrow and announces a sale for today, then customers react by shopping today and the firm regrets the decision to have a sale today. But an equilibrium exists in which consumers and firms make random decisions (the Blue Light Special). Suppose the firm offers a sale today with probability q. Then the customer who shops today gets 10 with probability q and 5 with probability $1-q$ for a total of $10q + 5(1-q)$. The payoff for shopping tomorrow is $4q + 8(1-q)$. The seller wishes to equalize the two payoffs. If they are different, the shopper will always shop when the sale is more likely, which is not good for the seller. So we have:

$$10q + 5(1-q) = 4q + 8(1-q) \tag{131}$$

$$9q = 3 \quad \rightarrow \quad q = \tfrac{1}{3} \tag{132}$$

So having a sale one third of the time today, and 2/3 of the time tomorrow is the best the firm can do. Similarly, the consumer does not want to give away to the firm which day they will be shopping, so they also randomize. Let p be the probability that a consumer shops today. The payoff to the firm of a sale today is then $5p + 8(1-p)$ and the payoff of a sale tomorrow is $10p + 4(1-p)$. Equalizing these two gives:

$$5p + 8(1-p) = 10p + 4(1-p) \tag{133}$$

$$4 = 9p \quad \rightarrow \quad p = \frac{4}{9} \tag{134}$$

Any other probabilities and the firm can have the sale when consumers are less likely to come, which is detrimental to the interests of consumers. So the mixed strategy Nash Equilibrium is to shop today with probability 4/9 and to have a sale today with probability 1/3.

Other examples of games of this type include Rock, paper, scissors; baseball (fastball or curve); and football (run versus pass).

B Using Mixed Strategies to Avoid Coordination

Consider two firms, Macy and TJ Maxx. Macy is a high priced retailer that carries a variety of nice clothes in all sizes (and thus higher inventory costs and higher prices) and TJ Maxx is a retailer who charges low prices, but carries whatever surplus nice clothes manufacturers happen to have, usually in odd sizes. Customers can shop at Macy, putting up with high prices but knowing they will find what they want, or they can go to TJ Maxx, paying lower prices if TJ Maxx happens to have what they want. Further, the more customers go to TJ Maxx, the more likely they are to be out of something. So the payoffs are:

		Customer B	
		Shop TJ Maxx	Shop Macys
Customer A	Shop TJ Maxx	5,5	10,7
	Shop Macys	7,10	4,4

Here two Nash Equilibria exist, corresponding to the customers shopping at different stores. If B predicts A will shop at Macys, then B should not shop at crowded Macys, where prices are high and the large crowd means Macys may be out of stock, but instead shop at the low price (and not crowded) TJ Maxx. But then A will shop at Macys and we have a Nash equilibrium. The game is symmetric, so A shops at TJ Maxx and B shops at Macys is also an equilibrium. Suppose B predicts A will shop at TJ Maxx with probability q. Then B's payoff is $5q + 10(1-q)$ if B shops at TJ Maxx and $7q + 4(1-q)$ if B shops at Macys. Payoffs are equal if $q = \frac{3}{4}$. The game is symmetric, so a mixed strategy exists in which each customer shops at the discount retailer with probability 3/4. Notice that the mixed strategy is not very efficient. With probability $\frac{3}{4} \cdot \frac{3}{4} = \frac{9}{16}$ the customers "bump into each other" at the discount store and one of them may go home empty handed. This example illustrates different retailing strategies, and how consumers adjust their behavior in response to these strategies.

By the way, this game was featured in the movie about John Nash: "A Beautiful Mind." However, the movie inexplicably states that the Nash Equilibrium is for all consumers to shop at the high priced retailer. Nash proved in his dissertation that every game has at least one mixed or pure strategy equilibrium.

IV Dynamic Games

Two versions of games played over time exist: games as above but repeated, and sequential games in which one player moves before the other.

A Finite Repeated Games

In most cases, firms play the above games against each other repeatedly. For example the price war game is played repeatedly. In the one shot game, if one firm cuts prices, the firm wins market share at the expense of the firm that holds prices, without any negative consequences. In reality, the game is repeated, so the a firm which may cut prices has to consider possible retaliation in the next period by the firm holding prices constant. Let's see if this alters the equilibrium strategies.

Recall the payoff matrix is:

		Firm B	
		Hold prices	Cut prices
Firm A	Hold prices	3,3	0,5
	Cut prices	5,0	1,1

The way to solve repeated games is via backward induction: start with the last period and work backwards. Let's suppose the price war game is repeated 3 times. Start with period 3. This is always equal to the one shot game. The Nash Equilibrium is for both players to cut prices. Each firm need not fear retaliation next period because the game is over. Now look at period 2. Each player knows both firms will cut prices in period 3. Thus, we can add one to the payoffs of each player, regardless of their actions. Thus period 3 is irrelevant for period 2: there is no hope that if you hold prices the other firm will do the same next period, because you already know the other firm will cut prices in period 3. Therefore, the Nash Equilibrium is again to cut prices for both firms in period 2. And so on. Thus the Nash Equilibrium in the repeated game is identical: always cut prices. The payoffs are equal to $1 + 1 + 1 = 3$ for both players.

B Infinitely Repeated Games

If the game never ends, the backward induction argument breaks down. There is no final period in which you know the other firm will cut prices. Also games in which the end point is unknown are equivalent to infinitely repeated games. The math of infinitely repeated games is too complex to discuss here, but we can discuss the optimal strategy.

Definition 28 *A* **Tit for Tat** *strategy is to hold prices in the first period, and then in subsequent periods play the move your opponent played the period before.*

Tit for Tat says if your opponent cuts prices, you should retaliate next period by cutting prices. If your opponent does not cut prices, you should cooperate and hold prices high next period. A famous result is that Tit for Tat is a Nash Equilibrium in the infinitely repeated game if firms care enough about the future. Suppose you know your opponent will play Tit for Tat, and you do not discount the future. Then you have the opportunity to get \$5 million immediately by cutting prices. But then your opponent will cut prices next period, and indeed every period thereafter (forcing you to get \$1 million each period), until you hold prices while your opponent continues to cut prices. So you must get zero in order to persuade your opponent to hold again. The sum of these two is $5 + 0 = 5$ which is less than $3 + 3 = 6$ you would get by simply continuing to hold prices, knowing that your opponent will cooperate as long as you do. However, if you do not care much about the future, it may be optimal to grab the high profits today, and then hold prices high later to persuade your opponent to begin cooperating again.

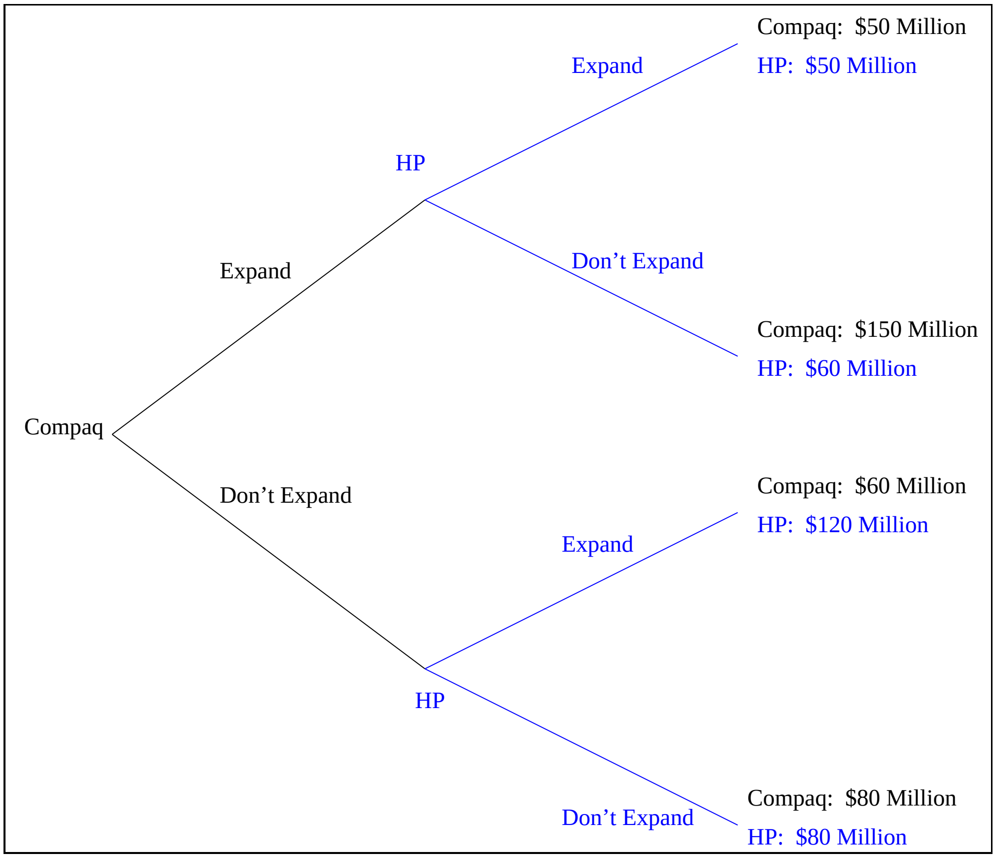
In general, Tit for Tat predicts that we will observe long periods of mutual cooperation, or long periods of mutual retaliation. In practice Tit for Tat can easily breakdown into a price war. If both players play Tit for Tat, if one firm, even by mistake, perceives the other as cutting prices, it will trigger a price war from which there is no escape.

Tit for tat is known as a “forgiving” strategy. You will allow those that have cheated you the chance to return to your good graces if they prove themselves. Other strategies, are less forgiving and work if firms care less about the future.

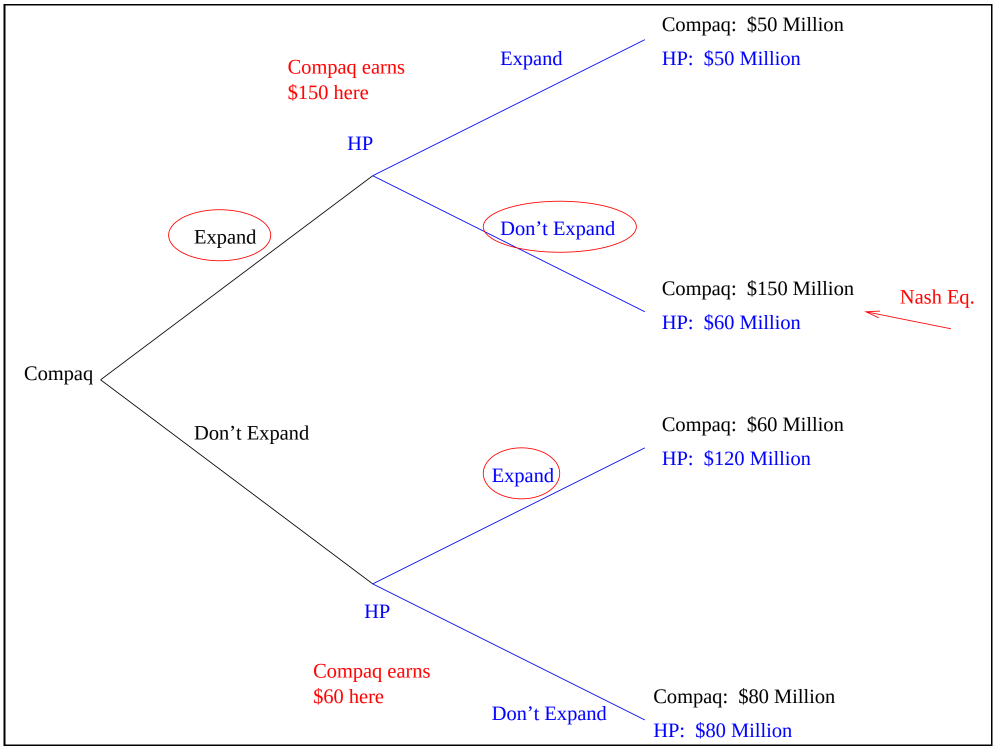
C Sequential Games

1 Extensive Form

It is easiest to represent sequential games in extensive form, that is, as a decision tree. Consider the anti-coordination game where one player now moves first. Compaq, the first mover, can either expand capacity in the PC market or not expand capacity. Then HP has the same choice. As in the anti-coordination game, if both firms expand in the PC market, the competition will be fierce and profits will be low for both firms. If one firm expands and the other firm does not, profits will be high for the firm that expands. The firm that does not enter makes more money than the case where both firms expand into the PC market, but less than if the firm entered and the other firm did not.



To solve this problem we again work backwards. If Compaq expands, HP does better by ceding Compaq the market and focusing business elsewhere (say on printers). If Compaq does not expand, HP does better by expanding into the PC business. Knowing this, Compaq can either expand, knowing HP will not expand, and make $150 Million, or not expand, knowing HP will expand, and make $60 million. Thus Compaq will expand. The Equilibrium, which we will call Sub-Game Perfect, is for Compaq to Expand and HP not to Expand. Compaq makes $150 Million and HP makes $50 Million.



Recall the problem of the simultaneous game that two Nash Equilibria existed and both players preferred a different equilibria, is solved in the sequential game. The first mover gets an advantage and gets the better Nash Equilibrium of the simultaneous game.

Definition 29 First Mover Advantage*: Advantage to the first mover in sequential games when the simultaneous game has multiple Nash Equilibria.*

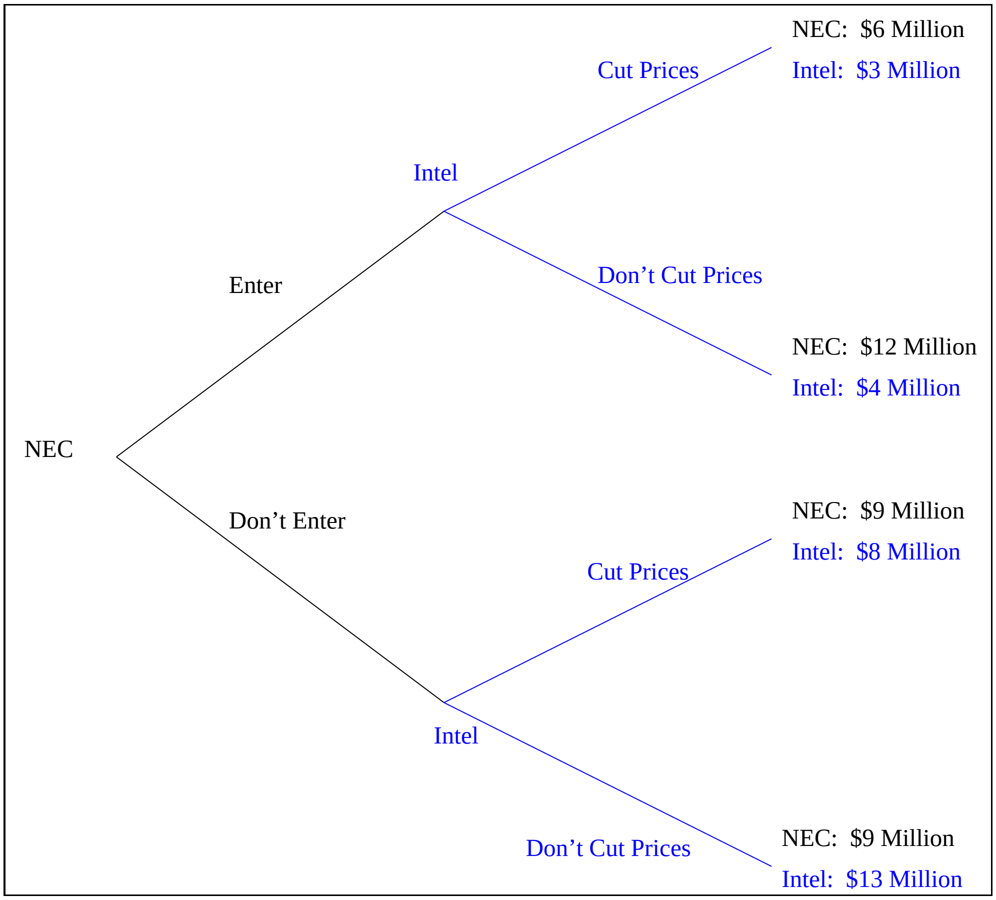
Notice also HP is powerless to threaten Compaq with retaliation if Compaq expands into the PC market. Compaq knows such a threat is not credible.

Definition 30 *A* **Sub-Game Perfect Equilibrium** *requires each sub-tree to be a Nash Equilibrium.*

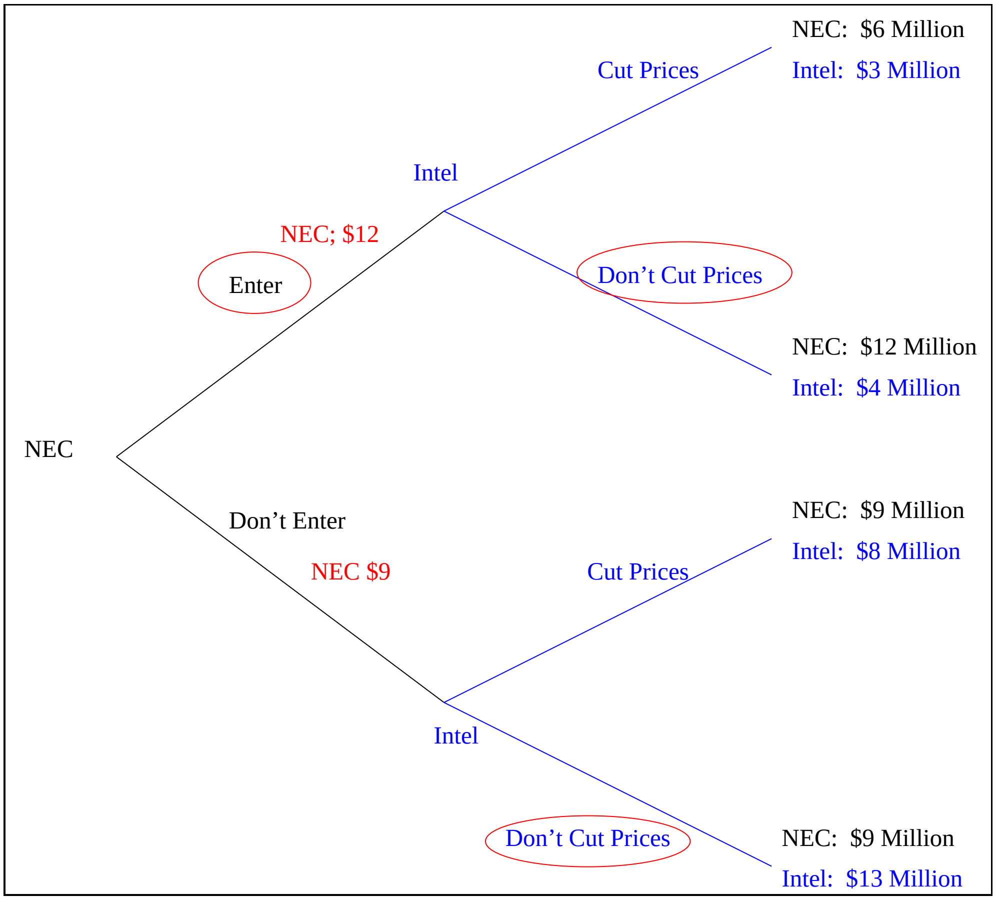
We see in this example that sub-game perfect equilibria are more stringent than Nash Equilibria (only 1 equilibrium exists, not two).

D Entry and Exit Games

An important strategy for the market leader in an industry is to deter entry by potential rivals. Suppose Intel dominates in terms of market share the market for computer memory chips. Intel knows a number of other makers of electronic parts could enter the market at any time, for example NEC, a Japanese firm. The payoff matrix is:

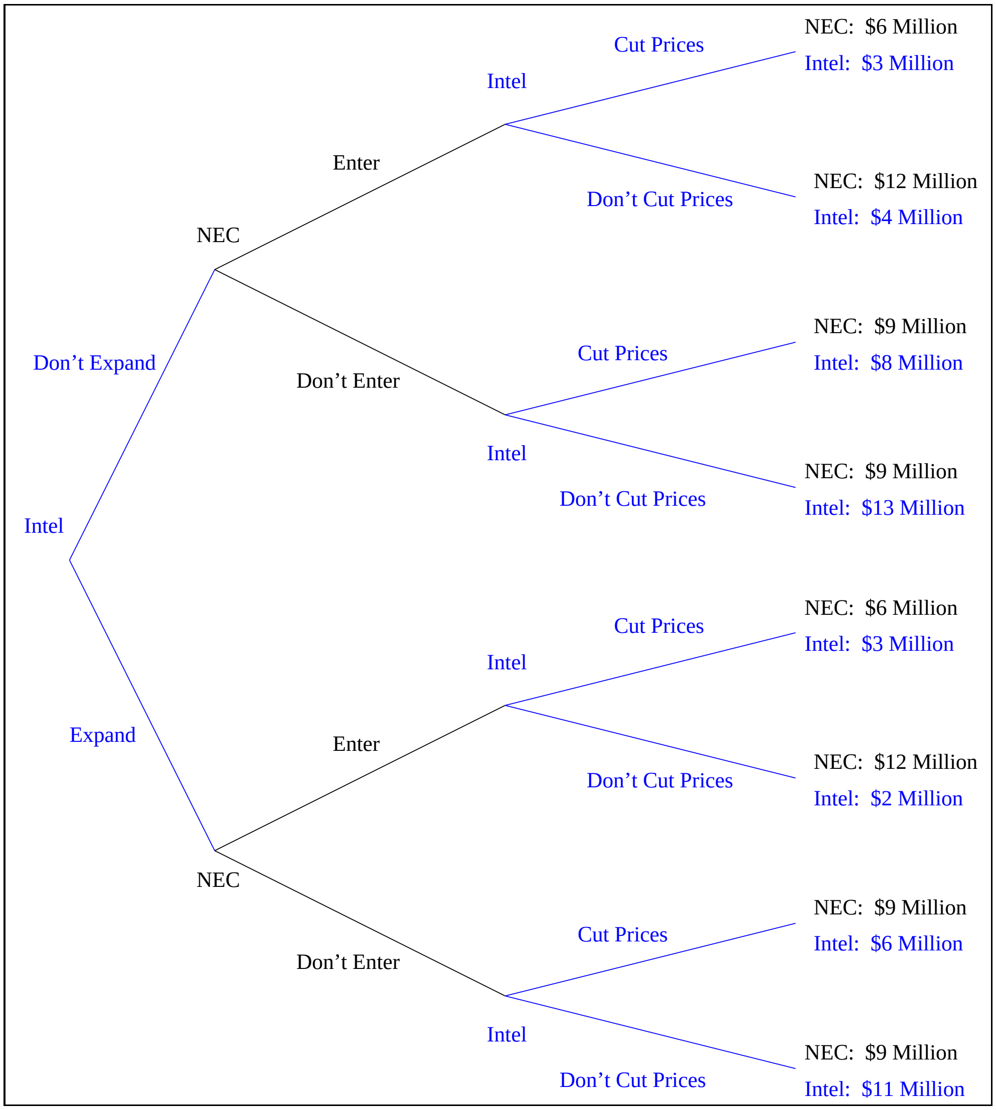


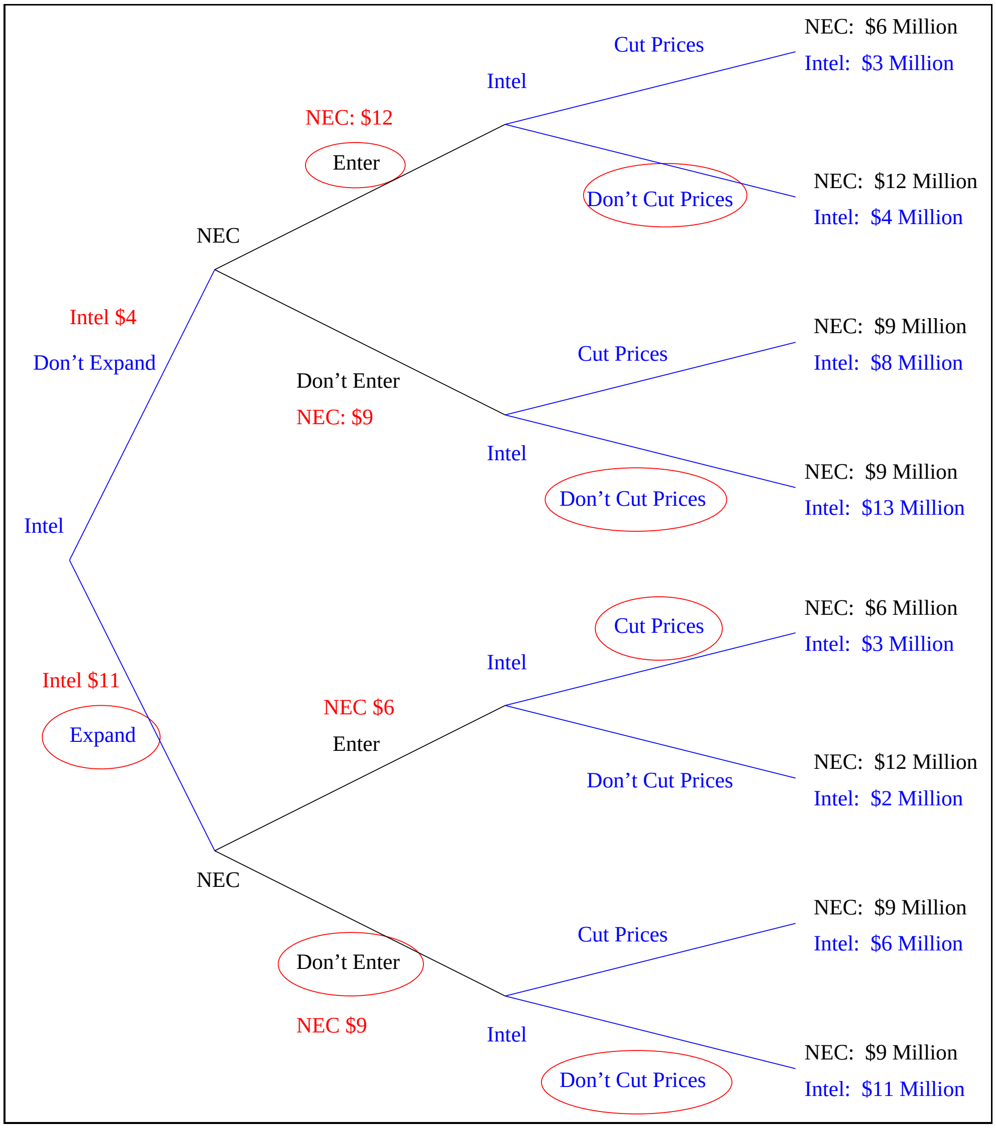
NEC moves first, by deciding whether or not to enter. Then Intel decides whether to respond by cutting prices and expanding output, or ignoring NEC and sharing the market. We solve the problem by backward induction. First, if NEC enters, then an ensuing price war would mean that Intel's profits are lower than if it instead kept prices high, making money from the most loyal customers, while ceding some of the market to NEC. If NEC does not enter, than Intel of course does much better holding prices high. So NEC has the choice of entering, knowing that Intel will not cut prices or not entering. Thus NEC enters.



Intel can threaten to cut prices, but NEC knows the threat is not credible and enters. Sub Game Perfection requires threats to be credible while the Nash Equilibrium does not. To see this, suppose NEC predicts Intel will cut prices if NEC enters. Then NEC should not enter. Then Nash Equilibria requires us to check whether or not our prediction is correct. But in this case the prediction does not matter, because NEC has decided not to enter. So we can say the prediction is correct.

Next suppose we add another move for Intel. Intel can add capacity or not add capacity before NEC decides whether or not to enter. If Intel adds capacity, then Intel can efficiently produce a large volume of chips if NEC enters. However, the expansion results in \$2 million of extra fixed costs if the factory is not used. The payoff matrix then changes as shown below, and NEC decides not to enter. Building capacity is one way to make threats more credible and deter entry. Building excess capacity is of course costly, however.


Intel
Don't Expand
Expand
NEC
Enter
Don't Enter
Intel
Cut Prices
Don't Cut Prices
NEC: $6 Million
Intel: $3 Million
NEC: $12 Million
Intel: $4 Million
NEC: $9 Million
Intel: $8 Million
NEC: $9 Million
Intel: $13 Million
NEC: $6 Million
Intel: $3 Million
NEC: $12 Million
Intel: $2 Million
NEC: $9 Million
Intel: $6 Million
NEC: $9 Million
Intel: $11 Million



Examples of entry deterence:

1. Du Pont in 1979 invests $0.33 billion in titanium dioxide plants to deter rivals with older plants from updating to newer, more competitive plants. Du Pont was later sued by the government for antitrust violations.

2. Wallmart's strategy is to build large stores in smaller towns first in order to deter others from building similar stores, since each town can support at most one store.