The Digital Economist

Lecture 7 – Strategic Behavior

A fairly recent development in microeconomics has been the introduction of **game theory** as an analytic tool to understand the behavior of individual economic agents. This particular form of modeling takes into account the use of *strategy* rather than marginal analysis to support the decision-making process. It is still assumed that economic agents engage in *optimizing behavior*. The difference is in the use of information of potential outcomes based on choices made by other agents.

Games can be developed under conditions of **complete**, **partial**, or **asymmetric information** among the players. The final solution or potential equilibrium of a game depends on actions and reactions of the players--reactions that may change if the game is repeated rather than played only once.

The basic tool of game theory is the **payoff matrix**. This matrix represents known payoffs to individuals (*players*) in a strategic situation given choices made by other individuals in that same situation. For example :

Agent A: / Agent B:	**Choice I**	**Choice II**
Choice I	$a_{1,1}$, $b_{1,1}$	$a_{1,2}$, $b_{1,2}$
Choice II	$a_{2,1}$, $b_{2,1}$	$a_{2,2}$, $b_{2,2}$

The entries 'a_{ij},b_{ij} ' represent numeric payoff to **Agent A** and **Agent B** respectively. If possible, choices made by each player will be independent of the actions of the other player--one player is ignorant of the choice to be made by the other. However, if for **Agent A**: $a_{1,j} > a_{2,j}$ for all values of 'j' then this person will always choose **Choice I**. This would represent a **dominant strategy** for **Agent A** The same could be true for **Agent B**: if $b_{i,1}$, $> b_{i,2}$ for all values of 'i', **Choice I** would be a dominant strategy for this second player.

When both players have a dominant strategy, an **equilibrium** exists in the model as defined by the cell corresponding to the optimal choices of both players. Even if only one player has a dominant strategy, an equilibrium can be determined given that the other player will react to this optimal choice made by the former.

For a numeric example:

Firm A: / Firm B:	**Choice I**	**Choice II**
Choice I	**1,2**	**3,1**
Choice II	**2,5**	**5,4**

The question is: *What choice will each firm actually make*?

If **Firm B** chooses **I** then **Firm A** will choose **II** since the payoff to firm **A** is higher (**$2.00 vs. $1.00**).

If **Firm B** chooses **II**, **Firm A** will still choose **II**.
So, independent of **Firm B**'s choices, **Firm A** will always make choice **II**-- *its dominant strategy*.

From **Firm B**'s point of view, if **Firm A** chooses **I, Firm B** will choose **I**.

If **Firm A** chooses **II**, **Firm B** will still choose **I**.

Firm B will always make choice **I**--*the dominant strategy*.

The payoffs in the lower left-hand corner (**A** = **II**, **B** = **I**) represent an equilibrium between these two players. The presumed strategy was the maximization of the individual payoffs.

MAXIMIN STRATEGIES

It will not always be the case that an equilibrium under this maximization strategy will exist. An example is the payoff matrix given below:

Firm A: / Firm B	**Choice I**	**Choice II**
Choice I	**1,2**	**4,0**
Choice II	**3,1**	**0,3**

Under maximization no equilibrium point exists:

- If **Firm A** chooses **I**, **Firm B** will choose **I**.
- If **Firm A** chooses **II**, **Firm B** will choose **II**
- If **Firm B** chooses **I**, **Firm A** will choose **II**
- If **Firm B** chooses **II**, **Firm A** will choose **I**

Firm A's choice depends on the choice made by **Firm B** and vice-versa. Instead a different strategy may be employed. This new strategy is to make the best of the worst-case scenario. In the case of **Firm A**, choosing **I** would mean a minimum payoff of $1.00 (if **B** chose **I**). If **Firm A** chose **II** then the minimum payoff would be $0.00 (if **B** chose **II**). So **Firm A,** taking a cautious approach would always choose **I**. **Firm B**, using the same strategy would also always choose **I**. This cautious strategy is known as a '**maxi-min**' strategy or *maximizing the minimum-possible payoff*.

EFFICIENT OUTCOMES

In the above games efficiency may be determined via the notion of **Pareto-Optimality** that is, given the point of equilibrium, *is it possible to make one person better off with-out harming the other person*? If not then the solution is Pareto Optimal or Pareto Efficient. If the equilibrium is not Pareto Optimal then a better outcome exists with respect to the goals of the players involved. A good example of an equilibrium not being Pareto optimal is a game known as the prisoner's dilemma with the payoffs being jail time:

Person A: / Person B	**Confess**	**Don't Confess**
Confess	**5,5**	**2,10**
Don't Confess	**10,2**	**3,3**

If both persons confess to the crime (*not knowing what the other will do*) they both get 5 years. If only one person confesses ("we did it"), he gets a lighter sentence for cooperation and the partner gets a longer sentence with a conviction based on solid evidence. If neither confess, it is more difficult for the state to present the case and expected sentences [*pr*(conviction)x(length)] will be lighter. In this game, both prisoners will confess (*the dominant strategy for both*) where as the Pareto optimal solution would be for neither to confess. Extensions in this case would be the nature of agreements, contracts, or collusion between the two players such that a Pareto optimal solution could be found. The game theorist would attempt to define in what manner such agreements would be sustainable and to what degree contracts could be enforced. Enforcement might be in the form of retaliation if one player defected from the agreement or made possible through repetition of the game.

Be sure that you understand the following concepts and definitions:

- Payoff Matrix
- Perfect (Complete) Information
- Partial Information
- Asymmetric Information
- Dominant Strategy
- Equilibrium
- Pareto Optimality
- Payoff Maximization
- Maximin Strategies
- Prisoner's dilemma
