The outcome where Jack and Jill each produce 40 instead of 30 is a Nash equilibrium.

Producing 40 instead of 30 is a dominant strategy for each player. A dominant strategy is a strategy that gives a higher payoff no matter what the opponent does.

Even though the payoff to each is higher when each produces 30, that outcome is not an equilibrium.

Game Theory

Game theory – study of how people behave in strategic situations – can be used to study oligopoly. Not needed for competition or monopoly. In oligopoly, each firm’s profit depends both on how much it produces and on how much other firms produce. When making production decisions, a firm considers how its decision affects the production decisions of the other firms.

One game, the prisoner’s dilemma, shows the difficulty of maintaining cooperation even if cooperation would make both players better off than non-cooperation.

Two criminals, Bonnie and Clyde, have been captured by the police. The police can convict both of them of carrying an unregistered gun, which would give them each 1 year in jail. The police also suspect that they have committed a bank robbery together, but need a confession to convict them.

Bonnie and Clyde are questioned in separate rooms, each offered a deal: If only one of them confesses to the bank robbery, that one will go free and the other will get 20 years. If both confess, they each get 8 years. If neither confesses, they each get 1 year.

Assume Bonnie and Clyde each care only about their own sentence.

The strategies and payoffs can be summarized in the following game form:

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>NC</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-8, -8</td>
<td>0, -20</td>
</tr>
<tr>
<td>NC</td>
<td>-20, 0</td>
<td>-1, -1</td>
</tr>
</tbody>
</table>

Bonnie reasons as follows: If Clyde confesses, then if I confess I get 8 years, if I don’t confess I get 20 years. So in that case it is better to confess. If Clyde doesn’t confess, then if I confess I go free and if I don’t confess I get 1 year. So
in that case it is better to confess. Thus, whatever Clyde does it is better for me to confess. Confessing is a dominant strategy for Bonnie.

Clyde reasons in the same way. Confessing is a dominant strategy for him too.

So the likely outcome is that they each confess. They each get 8 years in jail, worse for them them if they each hadn’t confessed.

Oligopolies face a similar situation to the prisoner’s dilemma. It is individually rational for each to defect from the joint monopoly output and produce more, even though the result is that each gets a lower profit than they would have by not defecting.

Jill and Jack’s situation can be summarized in the following table:

<table>
<thead>
<tr>
<th>Player 1</th>
<th>Arm</th>
<th>Disarm</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>1600, 1600</td>
<td>2000, 1500</td>
</tr>
<tr>
<td>30</td>
<td>1500, 2000</td>
<td>1800, 1800</td>
</tr>
</tbody>
</table>

Other examples of the prisoner’s dilemma

Arms races are like the prisoner’s dilemma. Consider the US and the Soviet Union during the Cold War. Each bears a cost of arming itself. But if the US does not arm itself and the USSR does, then the US is worst off. If the USSR does not arm itself and the US does, then the USSR is worst off.

The two countries’ situation can be summarized in the following table:

<table>
<thead>
<tr>
<th>Player 1</th>
<th>Arm</th>
<th>Disarm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arm</td>
<td>at risk, at risk</td>
<td>safe &amp; strong, at risk &amp; weak</td>
</tr>
<tr>
<td>Disarm</td>
<td>at risk &amp; weak, safe &amp; strong</td>
<td>safe, safe</td>
</tr>
</tbody>
</table>

In the arms race, arming is a dominant strategy. So the Nash equilibrium is for both countries to arm. This results in both of them being worse off than if neither had armed itself.

During the Cold War, the US and the USSR tried to negotiate over arms control. But each always had an incentive to cheat on the negotiations.

Common resources
Common resources can also be viewed as a prisoner’s dilemma problem.

Suppose Exxon and Chevron own adjacent oil fields. There is a common pool of oil worth $12 million under the fields. If each company drills one well each will get half the oil, earn $5 million profit – 6 million revenue minus 1 million costs.

Each company could also drill a second well at a cost of 1 million. If for instance, Exxon drills a second well and Chevron doesn’t, then Exxon gets two-thirds of the oil, leading to a profit of 8 million minus 2 million, or 6 million for Exxon, and only 3 million for Chevron.

But then Chevron would also drill a second well. This gives both companies a profit of 4 million. They are worse off each drilling two wells than each drilling just one well. But the Nash equilibrium will be (at least) two wells each.

<table>
<thead>
<tr>
<th></th>
<th>2 wells</th>
<th>1 well</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exxon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chevron</td>
<td>4, 4</td>
<td>6, 3</td>
</tr>
<tr>
<td>1 well</td>
<td>3, 6</td>
<td>5, 5</td>
</tr>
</tbody>
</table>

Prisoner’s Dilemma and Social Welfare

Cooperation can be hard to maintain even when it makes both players better off.

In some circumstances the lack of cooperation makes society worse off: arms race, common resources – additional weapons and additional wells drilled are a waste.

In the oligopoly situation, the lack of cooperation leads to a benefit to society. The competitive outcome is best for society – maximizes total surplus. Anything closer to the competitive outcome is better for society than the monopoly (collusion) outcome.

Why people sometimes cooperate.

Cartels do sometimes maintain high prices. Because they play the game many times. When game played many times, punishment for deviating can be incorporated into players’ strategies.

Suppose Jack and Jill play the game every week (And they know this). When they make initial agreement to keep production low, specify what one will do if
other defects. One possible agreement would be that if one party ever produces 40, then both will produce 40 from then on forever.

Depending on how much players discount future profits, this threat may be enough to prevent defection. The defector would get a profit of 1800 for only one time, then get a profit of 1600 forever after.

Repeated prisoners’ dilemma – to ensure cooperation, players must punish defection. Infinite punishment may not be the best strategy. It might be better to allow players to return to the cooperative outcome.

Political scientist Robert Axelrod held a tournament to find out what strategies work best. People sent in computer programs for playing prisoners’ dilemma games. The winner would be the one that spent the fewest total years in jail. The program that turned out best was the tit-for-tat strategy: Cooperate until the other player defects, then defect until the other player cooperates.

Public policy towards oligopolies

Cooperation among oligopolists leads to production levels that are too low and prices that are too high from the point of view of efficiency.

Antitrust laws

The courts refuse to enforce agreements among competitors to reduce quantity and raise price above the efficient level.

Sherman Antitrust Act of 1890 : "Every person who shall monopolize or attempt to monopolize, or combine or conspire with any person or persons to monopolize any part of the trade or commerce among the several States, or with foreign nations, shall be deemed guilty of misdemeanor..."

Clayton Antitrust Act of 1914 strengthened Antitrust laws more – If someone can prove that they were damaged by an illegal arrangement to restrain trade, they can sue and recover three times the amount of damages.