**Oligopoly & Game Theory**

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**Game Theory**

[Game theory](http://www.tutor2u.net/blog/index.php/economics/C186/) is mainly concerned with predicting the outcome of **games of strategy** in which the participants (for example two or more businesses competing in a market) have **incomplete information** about the others' intentions.

Game theory analysis has direct relevance to the study of the **conduct**  and **behaviour** of firms in oligopolistic markets – for example the decisions that firms must take over pricing and levels of production, and also how much money to invest in research and development spending.

Costly research projects represent a [risk](http://www.tutor2u.net/blog/index.php/economics/tagged/tag/risk/) for any business – but if one firm invests in R&D, can a rival firm decide not to follow? They might lose the competitive edge in the market and suffer a long term decline in market share and profitability.

The dominant strategy for both firms is probably to go ahead with R&D spending. If they do not and the other firm does, then their profits fall and they lose market share. However, there are only a limited number of patents available to be won and if all of the leading firms in a market spend heavily on R&D, this may ultimately yield a lower total rate of return than if only one firm opts to proceed.

**The Prisoners’ Dilemma**

* The classic example of [game theory](http://www.tutor2u.net/blog/index.php/economics/C186/) is the Prisoners’ Dilemma, a situation where two prisoners are being questioned over their guilt or innocence of a crime.
* They have a simple choice, either to confess to the crime (thereby implicating their accomplice) and accept the consequences, or to deny all involvement and hope that their partner does likewise.

*Confess or keep quiet? The Prisoner’s Dilemma is a classic example of basic game theory in action!*

* The “pay-off” is measured in terms of years in prison arising from their choices and this is summarised in the table below.
* No communication is permitted between the two suspects – in other words, each must make an independent decision, but clearly they will take into account the *likely behaviour* of the other when under-interrogation.

**Nash Equilibrium**
A Nash Equilibrium is an idea in game theory – it describes any situation where all of the participants in a game are pursuing their best possible strategy given the strategies of all of the other participants.
In a Nash Equilibrium, the outcome of a game that occurs is when player A takes the best possible action given the action of player B, and player B takes the best possible action given the action of player A.

|  |  |
| --- | --- |
|  Two prisoners are held in a separate room and cannot communicateThey are both suspected of a crimeThey can either confess or they can deny the crimePayoffs shown in the matrix are years in prison from their chosen course of action | Prisoner A  |
|    Confess  |    Deny  |
|  Prisoner B  | Confess  | (3 years, 3 years)  | (1 year, 10 years)  |
| Deny  | (10 years, 1 year)  | (2 years, 2 years) |

* What is the **best strategy** for each prisoner? Equilibrium happens when each player takes decisions which maximise the outcome for them given the actions of the other player in the game.
* In our example of the Prisoners’ Dilemma, the **dominant strategy** for each player is to confess since this is a course of action likely to minimise the average number of years they might expect to remain in prison.
* But if both prisoners choose to confess, their “pay-off” i.e. 3 years each in prison is higher than if they both choose to deny any involvement in the crime.
* In following narrowly defined self-interest, both prisoners make themselves worse off
* That said, even if both prisoners chose to deny the crime (and indeed could communicate to agree this course of action), then each prisoner has an **incentive to cheat** on any agreement and confess, thereby reducing their own spell in custody.

|  |  |
| --- | --- |
|  The equilibrium in the Prisoners’ Dilemma occurs when each player takes the best possible action for themselves *given the action of the other player*. The dominant strategy is each prisoners’ unique best strategy *regardless of the other players’ action*Best strategy? Confess?A bad outcome! – Both prisoners could do better by both denying – but once collusion sets in, each prisoner has an incentive to cheat!  |  Prisoner A  |
|     Confess  |     Deny  |
|  Prisoner B  | Confess  | (3 years, 3 years)  | (1 year, 10 years)  |
| Deny  | (10 years, 1 year)  | (2 years, 2 years)  |

**Applying the Prisoner’s Dilemma to business decisions**

* [Game theory](http://www.tutor2u.net/blog/index.php/economics/C186/) examples revolve around the **pay-offs** that come from making different decisions.
* In the classic prisoner’s dilemma the **reward to defecting** is greater than mutual cooperation which itself brings a higher reward than mutual defection which itself is better than the sucker’s pay-off.
* Critically, the **reward for two players cooperating** with each other is higher than the average reward from defection and the sucker’s pay-off.

Consider this example of a simple pricing game: The values in the table refer to the profits that flow from making a particular decision.

|  |  |
| --- | --- |
|   | **Firm B’s output** |
| *High output* | *Low output* |
| **Firm A’s output** | *High output* | £5m, £5m | £12m, £4m |
| *Low output* | £4m, £12m | £10m, £10m |

* Display of payoffs: row first, column second e.g. if Firm A chooses a high output and Firm B opts for a low output, Firm A wins £12m and Firm B wins £4m.
* In this game the reward to both firms choosing to limit supply and thereby keep the price relatively high is that they each earn £10m. But choosing to defect from this strategy and increase output can cause a rise in market supply, lower prices and lower profits - £5m each if both choose to do so.
* ***Example: Tesco fined for cartel pricing***
*Tesco plc has been fined £10m as part of a wider £50m penalty slapped on supermarkets and milk companies by the Office of Fair Trading after it ruled there had been collusion over the price of cheese and milk. The scam - dating back to 2002 and 2003 - was said to have cost consumers around £270m. Tesco continues to deny it colluded with the other companies.*
*News reports, summer 2011*

A dominant strategy is a strategy that is best irrespective of the other player’s choice. In this case the dominant strategy is competition between the firms.

* The **Prisoners’ Dilemma** can help to explain the breakdown of price-fixing agreements between producers which can lead to the out-break of price wars among suppliers, the break-down of other [joint ventures](http://www.tutor2u.net/blog/index.php/economics/tagged/tag/joint%2Bventure/) between producers and also the collapse of free-trade agreements between countries when one or more countries decides that protectionist strategies are in their own best interest.
* The key point is that game theory provides an insight into the **interdependent decision-making** that lies at the heart of the interaction between businesses in a competitive market.

**Prisoner's Dilemma and Climate Change Negotiations**
Can repeated games of the prisoner’s dilemma help climate negotiations?
With 2012 signalling the expiry date of the Kyoto Protocol, there is an urgent need for a successor treaty to tackle the ever-increasing global [emissions](http://www.tutor2u.net/blog/index.php/economics/tagged/tag/emissions/) problem.
The main issue with tackling [climate change](http://www.tutor2u.net/blog/index.php/economics/tagged/tag/climate%2Bchange/) is the cost to countries of implementing it. To be successful it will need profound transformation of energy and transport organisations, and changes in the behaviours of billions of consumers. The [Stern Review](http://www.tutor2u.net/blog/index.php/economics/tagged/tag/stern%2Breport/) admitted that it will likely cost 1% of GDP –even though it doesn’t seem much, it is double the amount currently spent on development aid worldwide.

* The **USA** sees a cap on emissions as a threat to [competitiveness](http://www.tutor2u.net/blog/index.php/economics/tagged/tag/competitiveness/), and to its global supremacy;
* The **developing world** denounces any calls for a cap on emissions as an effort by former colonial powers to hold back development;
* **Europe** has been making encouraging though patchy progress towards targets, driven mainly by a one-off switch from coal to gas.

The issue here is how countries can expect to make cuts in emissions when their economic competitors refuse. This in turn leads to the [**Tragedy of the Commons**](http://www.garretthardinsociety.org/articles/art_tragedy_of_the_commons.html) which occurs when a group’s individual incentive lead them to take actions which, overall, lead to negative consequences for all group members. A country that refuses to act, whilst the other cooperates, will experience a free-rider benefit - enjoying the advantage of limited climate change without the cost. On the flip side, any country that imposes limits, when its competitors do not, incurs not just the cost of limiting its own emissions, but also a further cost in terms of reduced competitiveness

The dynamics of the prisoner’s dilemma do change if participants know that they will be playing the game more than once.

In 1984 an American political scientist at the University of Michigan, [Robert Axelrod](http://www-personal.umich.edu/~axe/), argued that if you play the game repeatedly you are likely to see emerging is cooperative rather than defective actions.

He identified four elements to a successful strategy which is this case can be applied to climate negotiations:

1. **Be Nice** – sign up to unilateral cuts in [emissions](http://www.tutor2u.net/blog/index.php/economics/tagged/tag/emissions/), as deep as your economy and financing capacity allows.
2. **Be Retaliatory** – single out countries that have not commenced action and, in collaboration, find ways of pressurising them until they do so.
3. **Be Forgiving** - when non-compliant countries come onboard give them generous applause; signal that good behaviour will be rewarded with even deeper cuts in your own emissions.
4. **Be Clear** - let everyone know in advance exactly how you are going to behave – that you will work with them if they take action on emissions, and that you will retaliate if they do not.

Repeated Prisoner’s Dilemma provides valuable insight into how countries should act away from the negotiating table and over the longer term. Ultimately, for the planet’s sake, one hopes that everyone will play the game

*Source: Mark Johnston, EconoMax, December 2007*