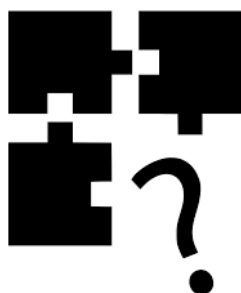


# A GAME THEORETIC APPROACH TO DEADLINE ADHERENCE

Microeconomics 871 Essay



**Jessica van der Berg - 20190565**

**Laura Meyer - 20748302**

**Cassandra Pengelly - 20346212**

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## 1. Introduction

Every day people, firms and governments have to make decisions, and often their decisions depend on other people's decisions. For example, it's only useful for people and firms to accept the Rand as money, if other people and firms accept the Rand as money. Economists have long been interested in modelling human behaviour, and game theory has been developed as a tool to help us better understand situations where people interact with one another and make decisions ([Osborne, 2004: 1](#)). One example of where game theory can be applied to explain how we make decisions is deadline adherence. At some stage in their lives, every person has had to submit an assignment, an essay or a report by some deadline. Game theory can offer insights as to when a person should submit work on time or late, even when there is incomplete information.

We investigate a case where a student is required to hand in an assignment but experiences a crisis before the deadline, and has to choose whether to submit her assignment on time or to hand in late. We impose a structure of continuous types for both players, with a discrete set of actions. This essay is structured as follows: section [2](#) briefly discusses the literature on games of incomplete information and some applications. Section [3](#) presents the deadline adherence game theory model; and section [4](#) analyses the results of the game. The final section concludes ([5](#)).

## 2. Games of Incomplete Information

We follow the approach of [Harsanyi \(1995\)](#) in applying a game theoretic model of incomplete information, where players have less than full information about each others' payoff functions. Based on the Bayesian methodology, the two players have expectations in the form of subjective probability distributions. We use a lottery to assign types to players, before any moves are made in the game. The two players then try to estimate the probability of each others' types, subject to the information that is commonly available. In order to solve the model, the game of incomplete information will be reinterpreted as a game with complete and imperfect information, by transforming the basic mathematical structure.

## 3. A Model of Deadline Adherence

A student receives an assignment, which is due by a certain date set by the lecturer. While the student is working on the assignment, she undergoes a crisis and therefore spends less time on the assignment. She has two options: she can hand in the assignment on time or she can hand in late. If she hands in on time, she will get a payoff of  $a - c$ , where  $a$  is the potential mark she would have received, and  $c$  is the negative impact the crisis has on her mark. However, if she submits her project late, she has

some time to recover after the crisis and reduce its academic impact. Her payoff is  $a - \beta c - m$  if the lecturer gives her a penalty, where  $m$  is the size of the penalty. She gets a payoff of  $a - \beta c$  if there is no penalty.  $\beta$  represents the type of the student, where a high  $\beta$  suggests a low resiliency to crises and a low  $\beta$  suggests a high resiliency and a better academic recovery.

On the other hand, the lecturer is faced with the decision either to give a penalty ( $m$ ) if a student submits late or not to give a penalty. If the lecturer gives a penalty, he feels bad since the student has gone through a crisis. The size of his disutility depends on the size of the penalty ( $m$ ) and how empathetic the lecturer is, where the level of empathy describes the lecturer's type ( $\delta$ ). The more empathetic the lecturer is, the higher  $\delta$  is. The lecturer's and student's types are independently and randomly chosen by nature at the start of the game from a uniform distribution:<sup>1</sup>  $\delta \sim Uniform$  and  $\beta \sim Uniform$ . If the lecturer decides not to impose a penalty,

A summary of the game's parameter's and restrictions are shown in figure 3.1 below.

Parameter	Parameter Represents	Restriction
$a$	Potential assignment mark	$0 \leq a \leq 1$
$c$	Cost of crisis to assignment mark	$0 < c \leq 1$
$\beta$	Student's type: level of resiliency	$\beta \sim Uniform$
$m$	Mark penalty	$0 < m \leq 1$
$\delta$	Lecturer's type: level of empathy	$\delta \sim Uniform$
$d$	Late deterrment utility	$0 < d \leq 1$

Table 3.1: Game Parameters

% latex table generated in R 4.0.4 by xtable 1.8-4 package % Sun Oct 17 14:46:31 2021

	$m_t^r$	$\delta p_t$	$R_t^r$	$R_t^b$	$y_t^r$
1	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00

Figure 3.2 shows the game in simultaneous format.

<sup>1</sup>A uniform distribution puts equal chance on any of the outcomes between 0 and 1 happening.

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	Penalty	No Penalty
On Time	$a - c, 0$	$a - c, 0$
Late	$a - \beta c - m, \delta m$	$a - \beta c, \delta c - d$

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Table 3.2: Simultaneous Game

Figure 3.1 shows the game below in extensive form:

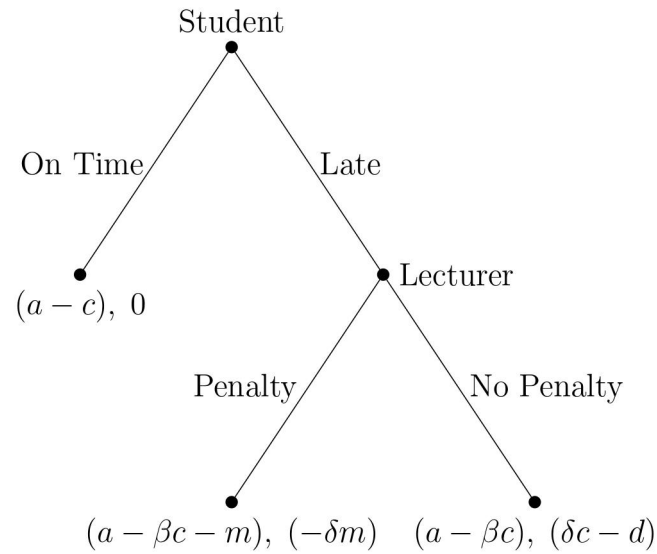


Figure 3.1: Game Tree

## 4. Results and Discussion

BR interperet Faults with game Run different examples

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	Penalty	No Penalty
On Time	0.65, 0	0.65, 0
Late	0.72, -0.01	0.77, -0.06

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Table 4.1: Simultaneous Game Best Response

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	Student	Lecturer
Best Response	Late	Penalty

Table 4.2: Best Response

## 5. Conclusion

Extensions, generality

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## References

10 Harsanyi, J.C. 1955. Games with incomplete information. *The American Economic Review*. 85(3):291–303. [Online], Available: <http://www.jstor.org/stable/2118175>.

Osborne, M.J. 2004. *An introduction to game theory*. Vol. 3. (3). Oxford university press New York.

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## Appendix

*Payoffs label{payoff}*

### Student payoffs:

$$\begin{aligned}E[\text{On Time}] &= a - c \\E[\text{Late}] &= p(a - \beta c - m) + (1 - p)(a - \beta c) \\&= -mp + a - \beta c\end{aligned}$$

Student plays on time if:

$$\begin{aligned}a - c &> a - mp - \beta c \\ \beta c &> c - mp \\ \beta &> \frac{c - mp}{c}\end{aligned}$$

Student plays late if:

$$\beta < \frac{c - mp}{c}$$

### Lecturer Payoffs:

$$\begin{aligned}E[\text{Penalty}] &= q(-\delta m) + (1 - q)(0) \\&= q(-\delta m) \\E[\text{No Penalty}] &= q(\delta c - d) + (1 - q)(0) \\&= q(\delta c - d)\end{aligned}$$

Lecturer gives a penalty if:

$$\begin{aligned}q(-\delta m) &> q(\delta c - d) \\ -\delta m &> \delta c - d \\ d &> \delta(c + m) \\ \delta &< \frac{d}{c + m} \\ \delta &< \bar{\delta}\end{aligned}$$



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Lecturer gives no penalty if:

$$\delta \geq \frac{d}{c+m}$$
$$\delta \geq \bar{\delta}$$

### *Best Responses*

Solving for the best responses:

$$p = \text{Probability that the lecturer gives a penalty} = \bar{\delta} = \text{Prob}(\delta < \bar{\delta})$$

Substitute into the student's best response function - student hands in on time if:

$$\beta > \frac{c - m(\bar{\delta})}{c}$$

Since  $0 \leq \beta \leq 1$ ,  $\beta$  cannot be greater than 1. This implies

$$\frac{c - m(\bar{\delta})}{c} \leq 1$$
$$c - m\bar{\delta} \leq c$$
$$-m\bar{\delta} \leq 0$$
$$0 \leq \bar{\delta}$$

Since  $0 \leq \bar{\delta} \leq 1$ , this condition will always hold.  $\beta$  cannot be less than 0:

$$\frac{c - m\bar{\delta}}{c} < 0$$
$$c - m\bar{\delta} < 0$$
$$-m\bar{\delta} < -c$$
$$\bar{\delta} > \frac{c}{m}$$

if  $\bar{\delta} > \frac{c}{m} \Rightarrow \beta = 0$ , otherwise:

$$\beta = \frac{c - m\bar{\delta}}{c}$$