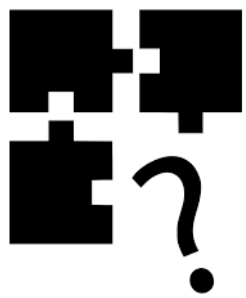
A GAME THEORETIC APPROACH TO DEADLINE ADHERENCE

Microeconomics 871 Essay



Jessica van der Berg - 20190565

Laura Meyer - 20748302

Cassandra Pengelly - 20346212

18 October 2021 | Word Count: 2980

Table of Contents

1. Introduction

The relationship between a supervisor and a subordinate have been studied extensively (Conrad, 1983),(Putnam & Wilson, 1982), (Liu & Shi, 2017). A subordinate's action is often influenced by the behaviour of the supervisor. Identity-based motivation theory describes that a positive relationship of trust and leniency between a subordinate and a supervisor will ultimately lead to both parties being better off in terms of reaching their goals, performance, and mental health (Liu & Shi, 2017). Game theory models have been used to analyze the interactions between a supervisor and a subordinate (Osborne, 2004: 1). A common situation that arises is a subordinate being assigned a task that should be complete before a deadline. Game theory can offer insights as to when a subordinate should submit a task on time or miss the deadline if there is incomplete information.

This article contributes to the existing literature by analyzing the dynamic relationship between a student and a lecturer. We investigate a case where a student is required to submit an assignment with a deadline restriction but experiences a crisis before the deadline and must choose whether to submit her assignment on time or miss the deadline. 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

Real-life situations often lack full information Trabelsi (2020). Von Neumann and Morgenstern (1944: 30 cited in Myerson, 2004) first used the term *incomplete information* to a game theory model in which parts of the normal form structure is unspecified. However, Von Neumann and Morgenstern (1944: 30 cited in Myerson, 2004) deemed any further research into this model as unimportant. Disagreeing Luce & Adams (1956) extended on the literature on incomplete information by assuming that each player has a perception, which could be correct or incorrect, of the payoff function of the other player. However, Luce & Adams (1956) did not consider uncertainty about strategies. Harsanyi (1995) addressed the concerns of Luce & Adams (1956) by developing a general analytical framework to analyze 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 other's payoff functions. Based on the Bayesian methodology, both players have expectations in the form of subjective probability distributions. Players have different types, which are randomly assigned and represents their belief about the game being played. However, players do not know the type of the other player Trabelsi (2020). Both players attempt to estimate the probability of each other's types, subject to the available information. 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. β represents the type of the student, where a high β suggests a low resiliency to crises and a low β 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 experienced a crisis. The size of this disutility depends on the size of the penalty and how empathetic the lecturer is - the lecturer's type (δ). The more empathetic the lecturer is, the higher δ 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:[1] $\delta \sim \mathsf{Uniform}$ and $\beta \sim \mathsf{Uniform}$. If the lecturer

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

Parameter	Parameter Represents	Range
a	Potential assignment mark	0<=a=<1
c	Cost of crisis to assignment mark	0<c=<1
B	Student's type: level of resiliency	0<=B=<1
m	Mark penalty	0<m=<1
D	Lecturer's type: level of empathy	0<=D=<1
d	Late determent utility	0=<d=<1

Table 3.1: Summary of Game Parameters

Figure 3.2 shows the game in simultaneous format.

[1]A uniform distribution puts equal chance on any of the outcomes between 0 and 1 happening.

	Penalty	No Penalty
On Time	a-c, 0	a-c, 0
Late	a-B(c) - m, D(m)	a-B(c), D(c)-d

Table 3.2: Simultaneous Game

Figure 3.1 shows the game below in extensive form:

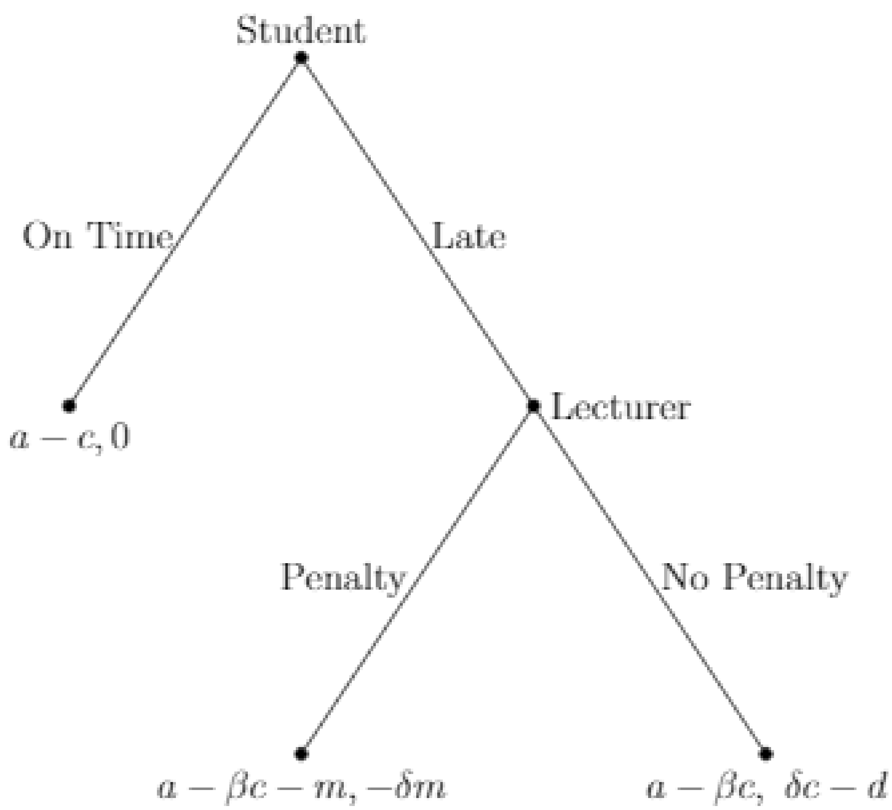


Figure 3.1: Game Tree

4. Results and Discussion

BR interperet Faults with game Run different examples

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

Table 4.1: Simultaneous Game Best Response

	Student	Lecturer
Best Response	Late	Penalty

Table 4.2: Best Response

5. Conclusion

Extensions, generality

References

10 Conrad, C. 1983. Power and performance as correlates of supervisors' choice of modes of managing conflict: A preliminary investigation. *Western Journal of Communication (includes Communication Reports)*. 47(3):218–228.

Harsanyi, J.C. 1995. Games with incomplete information. *The American Economic Review*. 85(3):291–303. [Online], Available: http://www.jstor.org/stable/2118175.

Liu, P. & Shi, J. 2017. Trust in the subordinate and deference to supervisor in china: A moderated mediation model of supervisor-subordinate guanxi and political mentoring. *Chinese Management Studies*.

Luce, R.D. & Adams, E.W. 1956. The determination of subjective characteristic functions in games with misperceived payoff functions. *Econometrica, Journal of the Econometric Society*. 158–171.

Myerson, R.B. 2004. Comments on "games with incomplete information played by 'bayesian'players, i–III harsanyi's games with incoplete information". *Management Science*. 50(12_supplement):1818–1824.

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

Putnam, L.L. & Wilson, C.E. 1982. Communicative strategies in organizational conflicts: Reliability and validity of a measurement scale. *Annals of the International Communication Association*. 6(1):629–652.

Trabelsi, M. 2020. Games with incomplete information: A framework based on possibility theory. PhD thesis. Université de Toulouse, Université Toulouse III-Paul Sabatier.

Appendix

5.1. Payoffs

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:

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

Lecturer gives a penalty if:

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

Lecturer gives no penalty if:

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

Solving for the best responses:

$$\therefore p = \bar{\delta} = \text{Prob}(\delta < \bar{\delta})$$

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

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

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

$$\begin{aligned} \frac{c - m(\bar{\delta})}{c} &\leq 1 \\ c - m\bar{\delta} &\leq c \\ -m\bar{\delta} &\leq 0 \\ 0 &\leq \bar{\delta} \end{aligned}$$

Since $0 \leq \bar{\delta} \leq 1$, this condition will always hold.