Deadlines, Procrastination and Task Quality: Role of missing information regarding task difficulty

Mahima Mukhija, Ashoka University

September 2023

Abstract

Procrastination is generally conceptualized as the unnecessary delay of an intended task. It is linked to poor mental health, poor individual performance, low academic scores, and decelerated job promotions. At the hands of important institutions and people in authority like policymakers, it can cause substantial harm to the masses. Traditionally, present bias has been used to understand procrastination in economics literature. This paper explores the role of information regarding task difficulty in understanding procrastination (delay accompanied by poor performance) via a theoretical model followed by a lab experiment to test the main results. Task quality as opposed to just task completion is studied both in the theoretical and experimental setup. Procrastination in the lab experiment is identified by directly observing the time allotted to task and task performance. The model predicts no effect of information variation on procrastination if there is enough gap between the time needed to complete the task and time available before the deadline due to endogenous learning. The empirical data supports this result and also shows evidence of learning behavior.

1 Introduction

Procrastination is generally conceptualized as the unnecessary delay of an intended task (Lay, 1986 [23]; Steel, 2007 [30]; Klingsieck & Katrin, 2013 [21]; Ferrari, 1993a [14]; and Lay & Silverman, 1996 [22]). The key emphasis is on "unnecessary" and "intended task", i.e., it is understood as a voluntary delay in performing a task even when doing so is expected to have harmful consequences (Akerlof, 1991 [2]; Burka & Yuen, 1983 [10]; Ellis & Knaus, 1977 [3]; Silver & Sabini, 1981 [28]). Procrastination can serve as a roadblock to achievements, both professional and personal. On a personal level, it can take a toll on mental health via routes of increased anxiety, depression, and low self-esteem (Ferrari, 1991 [13]; Duru et. al., 2017 [12]), and can lead to poor physical health as well, say due to prolonged delay in acquiring health insurance (Sirois, 2004 [29]). On the professional front, procrastination is linked to poor individual performance (Beswick et al., 1988 [7]; Steel et al., 2001 [31]; Wesley,1994 [32]), low academic scores, and decelerated job promotions (Legood et al., 2018 [24]). Procrastination in

decision-making and implementation at the hands of important institutions, and people in authority like policymakers can cause substantial harm to the masses. The mishandled or delayed response of some nations to the Covid-19 pandemic is one such example (Miraj, 2020 [27]).

Prominent economic work in this field identifies procrastination as arising from present bias where "present bias refers to the tendency of people to give stronger weight to payoffs that are closer to the present time when considering trade-offs between two future moments" (O'Donoghue & Rabin, 1999 [26]; Augenblick et al., 2015 [5]). Mathew Gibson, 2020 [9] paper identifies excessively optimistic beliefs about future demands on an individual's time as another source of procrastination. In this paper, I study the lack of information regarding task difficulty as yet another factor explaining procrastination. The three main research questions are: Does lack of information about task difficulty/ time needed to complete a task induce procrastination? Does delayed time allocation to a task (too close to the deadline) translate to low task output quality? Finally, how much of this unnecessary delay can be explained by present bias?

Some papers in psychology literature have looked at task-related factors which may affect procrastination (Lena et. al., 2022 [33]). This paper focuses on one such factor, namely, information regarding the time needed to complete an intended task. We conjecture that procrastination in case of full information regarding task difficulty is likely to be lower than in case of incomplete information as full information would likely make the individual get working on the task well in time to complete it if the task result is really valued. This prediction is supported by the results found in the theoretical model constructed in the paper to answer the main research questions.

The paper attempts to answer the main research questions through a theoretical model and then test its predictions through a laboratory experiment. First, a quasi-natural classroom experiment was conducted with two sections of second-year undergraduate students enrolled in the Introduction to Microeconomics course at Ashoka University. The data provided weak evidence of the provision of information regarding task difficulty or time needed to complete the task (here quiz) leading to reduced procrastination (task delay) and improved performance. However, there was scope for uncontrolled factors like emergency work that may have come up to affect the results. One uncontrolled factor that likely affected the data was the Covid peak during the second half of the course (which is also when the evidence was missing) leading to reduced quiz submissions. Taking motivation from this weak evidence, a theoretical model was constructed to understand the effect of lack of information regarding the time needed to complete a task on procrastination (delay accompanied by performance deterioration). Following this, a lab experiment was designed and conducted so as to test the predictions of the theoretical model in a more controlled environment. The results of the lab experiment show that there is a strong negative relationship between delay and task performance, the same as in the case of the classroom experiment. But this delay could neither be explained by task information nor present bias. However, the data suggests endogenous learning in the absence of full information regarding task difficulty to be the reason behind the missing effect of lack of information on procrastination. This explanation is supported by the results of the theoretical model.

1.1 Literature Review

First and foremost, this paper relates to the experimental literature on procrastination. Most of the existing work identifies procrastination by time inconsistency in choices regarding when to perform the task. This approach draws upon the seminal theoretical work on procrastination, namely Rabin et al. 1999 [26] and Akerlof 1991 [2]. Ariely & Wertenbroch, 2002 [4] paper measures procrastination via demand for commitment which is expected to be present due to time inconsistency arising from present bias. An individual is said to be time inconsistent if his/her preference over two choices changes as time passes. In this paper, procrastination is identified by observing the actual time allocated to task and task performance when the given task is to be performed over a period of time in the lab. The direct observation opens the scope to incorporate a general definition of procrastination in the study that may or may not include time inconsistency. Also, as mentioned in the introduction, there has been empirical evidence of procrastination leading to poor performance (Farkes et. al., 2016 [15]; Beswick et al., 1988 [7]). This paper introduces that aspect in the theoretical and the experimental setup.

Secondly, it relates to the literature on explanations for procrastination. An explanation majorly accepted in the existing economics literature is "Present Bias" (O'Donoghue & Rabin, 1999 [26]; Augenblick et al., 2015 [5]). The existing theoretical models on procrastination in economics take task difficulty to be given. In Rabin et al., 1999 [26], the task must be done exactly once before a deadline. While in Akerlof, 1991 [2], a fixed number of hours have to be put on the task that needs to be completed before a deadline. Thus, a major contribution of the paper in this area is the introduction of uncertainty about the time needed to complete a task.

Thirdly, this paper relates to the literature on missing information v/s preference identification. Jayson L. Lusk et al., 2014 [25] paper distinguishes beliefs (arising from missing information) from preferences in food choices. There are some papers on discrimination as well that distinguish between taste-based and statistical discrimination (Becker, 1968 [6]; Yves Zenou et al., 2021 [19]). This paper is similar in spirit though the context is very different. The paper explores whether procrastination can be explained by a lack of information regarding the time needed to complete a task (missing information) and present bias (preference). The Mathew Gibson, 2020 [9] paper separates the time inconsistency explained by imperfect information about future demands on an individual's time from that explained by present bias.

This study also relates closely to procrastination literature in psychology. Though limited in number, there have been studies that have looked at task-related factors affecting procrastination among students. Previous studies suggest that procrastination is high among students when they believe that the information about goals, sequential actions, or means required to accomplish a task is incomplete, vague, or ambiguous (Ackerman & Gross, 2005 [1]; Blunt & Pychyl, 2000 [8]; Hoppe, Preissler, & Förster, 2018 [17]; Hoppe, Prokop, & Rau, 2018 [18]; and Lena et. al., 2022c[33]). These papers use the self-reported diary entry data of subjects to establish their results. This paper looks at ambiguity regarding a different aspect of the task, namely, the time needed to complete the task in a controlled laboratory environment where the outcome data

is incentivized choices or decisions by subjects as opposed to self-reported data which always carries the risk of misreporting.

Apart from the above, the study relates closely to the Economics of Education as one of the experiments is conducted in a classroom setting. Most of the existing work on academic procrastination in economics is either experimental or empirical, mainly focused on either measuring procrastination or linking it to poor academic performance (Airely and Wertenbroch, 2002 [4]; Kader, 2014 [20]). This study further explores the link between procrastination and poor academic performance by exploring the role of missing information regarding the time needed to complete a task in explaining procrastinating behavior.

The paper is split into 3 sections. Section 2 covers the theoretical model. Section 3 covers the lab experiment with subsection 3.1 covering the design, 3.2 covering testable predictions based on the theoretical model, and 3.3 covering the results. Section 4, the last and final section covers the conclusion and discussion regarding future research exploration.

2 Theoretical Model

2.1 Primitives

An (n period) individual agent model where a single intended task is to be performed before a deadline is considered. The deadline is captured by n which is the number of periods before the deadline and task difficulty is captured by k which is the number of effort units that are needed to complete the task to the best of quality. The agent's action set consists of effort choice e_i in every period $i \in \{1, 2, ..., n\}$, (choice e_i is made in time period i) i.e., in every period before the deadline the agent chooses the effort level to be exerted in that period. There is a convex effort cost equal to ${e_i}^2$. Task quality is proportional to the number of effort units exerted by the agent before the deadline, i.e., it is increasing in effort and is maximum when the total effort exerted is greater than or equal to k.

Effort in every period i is bounded above by 1, i.e., $e_i \leq 1 \; \forall i$. So the total effort that can be exerted before the deadline is bounded above by n. It is assumed that there is enough time before the deadline to complete the task to the best of quality, i.e., $k < n$.

2.2 Benchmark Case

Under the benchmark case, there is no present bias, and task difficulty k is known. The agent's instantaneous utility in any period i (u_i) equals negative effort cost ($-{e_i}^2$) and the total inter temporal utility (U) at any time period t equals $\sum_{i=t}^{n} -\delta^{i-t}{e_i}^2$ where δ is the future discounting factor ($0 \leq \delta \leq 1$).

The agent faces a discrete finite time period utility maximization problem (max U_i) where effort ($0 \leq e_i \leq 1$) is continuous. The agent aims to complete the task to the best quality at minimum cost so the agent's problem is equivalent to a cost minimization problem (min $-U_i$) subject to total effort being at least equal to k. Under

the benchmark case where task difficulty (k) is known and there is no present bias, the agent's problem at time period 1 is as follows:

$$min \sum_{i=1}^{n} \delta^{i-1} {e_i}^2 \qquad s.t. \sum_{i=1}^{n} e_i \geq k$$

The objective function above is the negative of the present discounted value of the agent's utility for n periods before the deadline at time period 1. The constraint here captures the agent's desire to achieve the best quality thus the total effort exerted in n periods must be greater than or equal to k. The agent solves this problem at time period 1 and then in every time period t it solves a similar problem which looks as below:

$$min \sum_{i=t}^{n} \delta^{i-t} {e_i}^2 \qquad s.t. \sum_{i=t}^{n} e_i \geq k - \sum_{i=1}^{t-1} e_i$$

The objective function here is the negative of the present discounted value of the agent's utility from period t till n at time period t. The constraint ensures that the effort for the remaining periods (t till n) must be such that the target effort k is met so as to achieve the best quality.

2.3 Unknown task difficulty without present bias

Under unknown task difficulty, k is i.i.d. uniformly distributed on $(\underline{k}, \overline{k})$, i.e., $k \sim U(\underline{k}, \overline{k})$ and this distribution is common knowledge. The agent doesn't know the exact task difficulty (k) so he/she works with an expected value of k which appears in the constraint. The agent's problem at time period 1 is as follows:

$$min \sum_{i=1}^{n} \delta^{i-1} {e_i}^2 \qquad s.t. \sum_{i=1}^{n} e_i \geq \frac{\underline{k} + \overline{k}}{2}$$

The objective function remains the same as with known k. However, since k is unknown, the constraint is different. The total effort units exerted for n periods must be greater than or equal to the expected value of k.

The belief regarding the target effort units or expected value of k is updated in every period using Bayes' rule. Before every period, the agent gets to know whether realized k effort units have been exerted till the previous period or not.

2.4 Present Bias

Present bias is captured by hyperbolic discounting with parameters δ and β where δ is the long-term discounting factor and β is the parameter of present bias ($0 \leq \delta \leq 1$, $0 \leq \beta \leq 1$). When k is known, the problem for a present biased agent looks as follows:

$$min \;\; {e_1}^2 + \beta(\sum_{i=2}^{n} \delta^{i-1} {e_i}^2) \qquad s.t. \sum_{i=1}^{n} e_i \geq k$$

When k is unknown, the objective function remains the same while the constraint changes. The problem looks as follows:

$$min \;\; {e_1}^2 + \beta(\sum_{i=2}^{n} \delta^{i-1} {e_i}^2) \qquad s.t. \sum_{i=1}^{n} e_i \geq \frac{\underline{k} + \overline{k}}{2}$$

The agent is assumed to be naive. A naive present biased agent has a positive β (i.e., he/she has present biased preferences) but is not aware of the same. Therefore, when solving the problem at time period 1, the agent doesn't take into account that when he/she will be in time period 2, the discounting differential between period 2 effort cost and period 3 effort cost will be different than it is at time period 1.

2.5 Key Results

There is a positive effort in time period 1 in all cases due to convex cost and the effort level (weakly) increases as the agent gets closer to the deadline due to future discounting. This delay (higher effort level closer to the deadline) is higher for a present biased agent. Owing to updated beliefs in every period, the expected value of k under unknown task difficulty increases before every period post $\underline{k}$ effort units are crossed if realized k is more than the total effort exerted till the previous period[1]. Following this, the agent exerts an even higher effort in the later periods.

There is no task quality loss when k is perfectly known both with and without present bias. Task quality loss is possible under unknown task difficulty and this possibility is higher for a present biased agent. However, with sufficient gap between maximum difficulty ($\overline{k}$) and number of periods till the deadline (n), there is no task quality loss, i.e., there is no task quality loss if there is sufficient time before deadline to catch up by learning. Also, the possibility of task quality loss is increasing in the variance of k distribution, i.e., the lower the variance (more precise the information about k), the lower the chances of task quality loss (ceteris paribus).

3 Lab Experiment

A laboratory experiment is conducted to test the key results of the theoretical model. The subsections below talk about the experiment design, the testable hypothesis based on the theoretical model, and the key results.

3.1 Experiment Design

Procrastination is directly observed in a controlled laboratory environment by conducting a three-week-long experiment[2] where the subjects are undergraduate students

[1]Before $\underline{k}$ units of effort are exerted, there is no new information learned. However, if more effort is needed in a period t after having exerted more than or equal to $\underline{k}$ effort units till the previous period, the agent updates his/her belief regarding the lower bound on uniform k distribution. It is believed that $k \sim U(\sum_{i=1}^{t-1} e_i, \overline{k})$, the expected value of k is updated accordingly, and the same appears in the constraint.

[2]The experiment was coded using oTree [11].

Figure 1: Typing task used in the experiment

from Ashoka University. The length of the experiment is kept long to allow for future discounting and present bias to have an impact. Present bias and risk preference are measured at the end of the experiment[3].

The subjects are given a tedious[4] task of typing random sequences of alphabetical letters and numerical characters of a fixed length using a keyboard. A single task is shown in Figure 1. The number of tasks assigned is either 10 or 20, the former being the short type and the latter being the long type. The choice of the task was based on a pilot, that consisted of several tedious tasks, and our rationale behind the task we chose is that it doesn't require the use of cognitive ability but the performance still depends on the time spent.

The subjects have one and a half hours in total to complete this task. This duration is spread across three periods of half an hour, one per week. The subjects are required to sit in the lab for 30 minutes each week on the same day (of their choice). On each day, they are free to work on the task for those 30 minutes or do whatever they like, for example, read books, listen to music, watch videos, etc. as long as they don't make noise. They get the participation fee (around Rs. 320 on average) [5] only after spending those 30 minutes on all three days in the lab. The restriction to spend those 30 minutes in the lab every week is there, as in its absence people might choose to work on the first day itself so that they won't have to come in the next two weeks [6]. Also, if subjects are allowed to leave the lab in case they choose to not work on a particular day, the subjects might work on the first day itself to allow themselves the flexibility of doing something else that might come up in the future.

The intervention of interest here is information regarding the task type. Before the 30 minutes to work on the task begin on the first day, the subjects have to type out two trial tasks, the results for which are shown to them immediately which includes the time taken and accuracy. This is done so that they understand the task and also get to know how long it takes to type a standard task. Under no information treatment, subjects are told that the number of tasks to be performed lies between 10 to 20 but the

[3]Time inconsistency is measured using the standard multiple price list(MPL) method over monetary payments. A simplified Holt and Laury [16] estimate is used to measure risk preference.

[4]subjects reported the task to be tedious on average in the pilot study.

[5]Rs. 50 apart from this 320 were paid on Day 1 itself for showing up.

[6]Ned Augenblick, 2015 follow a similar approach of having minimum work on each of the three dates in their experiment in order to force the subjects to incur the transaction cost of logging into the system on each date. The papers measuring time inconsistency over monetary payments follow a similar approach where minimum payments are imposed on multiple dates to avoid subjects choosing allocations on a single date so that they don't have to incur the transaction cost of coming to collect payment on multiple days (Andreoni and Sprenger, 2012a)

exact number is not given. Under the information treatment, they are told the exact task type, i.e., they are told the exact number of tasks to be performed which is 10 for short type and 20 for long type.

	Information	No information
Short	$T_{S,I}$	$T_{S,N}$
Long	$T_{L,I}$	$T_{L,N}$

Table 1: Treatment design

A 2X2 design as shown in table 1 is followed. The subjects are randomly assigned to one of the four treatments. Under complete information treatments ($T_{S,I}$, $T_{L,I}$), the subjects are expected to allocate their time such that they don't end up losing task performance fee[7], that is they don't delay to the extent that it affects their payoff from task performance. For the purpose of the study, sub-optimal delay is defined as delay to the extent that there is not enough time left for the task to be performed without mistakes. For the rest of the paper, delay and sub-optimal delay are used interchangeably.

3.2 Testable Predictions

The predictions are made on the basis of the theoretical model. Firstly, there would be no sub-optimal delay under full information for both short and long tasks. Secondly, there would be no effect of information treatment for the short task type as the exact number of tasks 10 is less than the expected value of 15 in the absence of full information. Thirdly, for the long task type, the sub-optimal delay would be higher under no information treatment than under full information[8]. Lastly, sub-optimal delay under the long, full information treatment would be higher for subjects with high present bias.

3.3 Results

As mentioned before, procrastination is task delay with cost in terms of performance. I define three binary measures of delay here. $delay\_1 = 1$ if the number of tasks left for period 3 is more than the number of tasks performed in period 2, 0 otherwise. $delay\_2 = 1$ if the number of tasks left in period 3 is more than 7 [9], 0 otherwise. $delay\_3 = 1$ if the number of tasks left for period 3 is more than the number of tasks that can be performed by the individual in half an hour as per the time taken in trial

[7]The task performance fee is paid depending on the typing accuracy. For the purpose of accuracy calculation, incomplete task is treated as error. The participation fee is 400 times the accuracy points where accuracy points lie between 0 to 1. The subjects are informed about this on the first day before the tasks begin.

[8]This is also consistent with the weak evidence found in the classroom experiment.

[9]the cutoff picked is 7 because the average number of tasks that can be performed in half an hour as per the time taken during trial tasks is 7.96. For trial task accuracy $> .80$, it is 7.89

tasks, 0 otherwise. Three measures are chosen to ensure that the results are not driven by the specific definition of the delay measure.

The other important measure is the measure of performance which is termed as Avg_E in this paper and it captures the average error per task with incomplete tasks treated as errors. Here, error means the number of letters typed incorrectly or not attempted. Thus, its value must lie between 0 and 128[10]. Table 2 below shows mean Avg_E by different delay measures.

Mean Avg_E	0	1	Total
*delay*_1	1.72	24.11	5.35
*delay*_2	2.40	22.69	5.35
*delay*_3	2.48	19.05	5.35

Table 2: Performance Measure

The total average error is 5.35, i.e., on average a subject missed or typed 5.35 letters per task incorrectly. The first row in Table 2 shows how average error varies depending on whether there was a delay as per *delay*_1 measure or not. The average error goes up from 1.72 to 24.11 when there is a delay which is a very high rise in average error. The same is true for the other two delay measures. Thus, there is a significant negative relationship between delay and performance. The same can be seen in the regression results in table 3 where column one is basic OLS regression of Avg_E on *delay*_1, column 2 controls for performance in trial tasks and also time taken during trial tasks, the regression coefficient on *delay*_1 remains positive and significant [11].

It is clear from the above discussion that there is a strong negative relationship between delay and performance. So the cost of delay has been established, what's left is to understand what causes this delay to get the answer to what causes procrastination. Table 4 shows the delay measures for different treatments. To summarise, there is almost no delay for the short task as predicted, there is delay for the long task but there is almost no effect of information treatment on delay regardless of the delay measure. This is in contrast to the prediction based on the theoretical model.

The same result of no effect of information treatment on *delay*_1 can be seen on doing a regression analysis even after controlling for present bias and risk preference. In all three columns of table 5 the coefficient on $T_{L,N}$ and $T_{L,I}$ is significantly positive, that is delay is higher for long tasks irrespective of whether there is full information or not. The difference between the regression coefficients for these two treatments is very low and it changes sign once controls are added in columns 2 and 3. Whether this difference, which captures the information treatment effect for the long task type, is significant or not can be looked at in table 6 which shows the effect of information treatment when data is restricted to only long task types. The coefficient on information is statistically insignificant even after controlling for the time taken in trial tasks, present bias, and

[10] 0 implies all tasks are completed fully with no mistakes at all and 128 implies all the tasks performed are completely incorrect

[11] The regression results are similar for *delay*_2 and *delay*_3.

VARIABLES	(1) Avg_E	(2) Avg_E
delay_1	22.39***	22.69***
	(2.103)	(2.188)
Trial Performance		8.691
		(9.918)
Trial time		-0.00242
		(0.00458)
Constant	1.718**	-5.524
	(0.847)	(9.605)
Observations	179	179
R-squared	0.390	0.394

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3: Effect of delay on performance

	$T_{S,N}$	$T_{S,I}$	$T_{L,N}$	$T_{L,I}$
$delay\_1 = 1$	2	1	13	13
$delay\_2 = 1$	0	0	13	13
$delay\_3 = 1$	0	0	15	16

Table 4: Information treatment and delay

risk preference. The regression coefficient for Trial Time is positive and significant in both table 5 and table 6, which shows that people who take a lot of time to perform the trial tasks tend to delay in the main task as well. However, the magnitude is very low. [12]

The data shows some evidence of endogenous learning as can be seen in Fig 2 which shows the average time spent on each task for different treatments. The fall in time spent on each task (increase in speed) is faster for the long type with full information (LI) than the short type with full information (SI) as can be seen from linear fitted values in Fig 2. For the no information [NI] treatment (Incomplete Information), the increase in speed rises post 10 tasks. Under NI, the slope of the fitted line for the first 10 tasks is similar to SI. However, post 10 tasks, it matches that of LI. [13] Thus, for the first 10 tasks, the subjects under no information treatment behave similar to the ones under short, full information treatment and post 10 tasks, they behave similar to the

[12]The results are qualitatively the same for *delay_2* and *delay_3*

[13]For 1st 10 tasks, the slopes for SI and NI are not significantly different from each other and that for NI and LI are significantly different from each other at 87% confidence limit, vice versa post 10 tasks.

VARIABLES	(1) delay_1	(2) delay_1	(3) delay_1
$T_{L,N}$	0.248***	0.228***	0.245***
	(0.0748)	(0.0728)	(0.0793)
$T_{S,I}$	-0.0280	-0.0447	-0.0572
	(0.0722)	(0.0703)	(0.0776)
$T_{L,I}$	0.262***	0.229***	0.192**
	(0.0756)	(0.0741)	(0.0811)
Trial time		0.000486***	0.000511***
		(0.000143)	(0.000152)
Risk Preference			0.0141
			(0.0135)
Present Bias			0.544
			(3.985)
Constant ($T_{S,N}$)	0.0476	-0.178**	-0.822
	(0.0535)	(0.0842)	(4.006)
Observations	179	179	162
R-squared	0.135	0.189	0.190

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: OLS regression of *delay_1* on information treatment and other controls

VARIABLES	(1) delay_1	(2) delay_1	(3) delay_1
Information	0.0141	-0.0124	-0.0625
	(0.100)	(0.0936)	(0.0973)
Trial Time		0.000961***	0.00104***
		(0.000258)	(0.000275)
Risk Preference			0.00696
			(0.0218)
Present Bias			4.729
			(6.370)
Constant	0.295***	-0.189	-4.979
	(0.0700)	(0.145)	(6.412)
Observations	86	86	80
R-squared	0.000	0.143	0.167

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: OLS regression of *delay_1* on information treatment for long type tasks

ones under long, full information treatment. This is in alignment with the endogenous learning (belief update) in the theoretical model.

In the experiment, the average time needed to complete a single task was 3 minutes[14]. So the maximum time needed to complete 20 tasks was 60 minutes while the time given was 120 minutes (30 extra minutes). Thus, there was sufficient time before the deadline for a subject under $T_{L,N}$ (long, no information) treatment to learn and catch up by increasing speed closer to the deadline without negatively affecting the performance[15]. This would explain the null effect of information treatment on sub-optimal delay. However, the presence of sub-optimal delay under long task treatment is in contrast to the model prediction.

4 Conclusion and Discussion

The paper finds no evidence for any effect of information regarding the time needed to complete a task on procrastination in the lab experiment which is quite striking as having perfect information would likely make the individual get working on the task well in time to complete it efficiently if the task result is really valued. Also, this is in contrast to the weak evidence found in the quasi-natural classroom experiment.

[14]the average time taken to complete a single task was 3 minutes in the pilot study conducted to pick a suitable task.

[15]this aligns with the key result in the theoretical model on the values on maximum task difficulty and time periods before the deadline on task quality loss

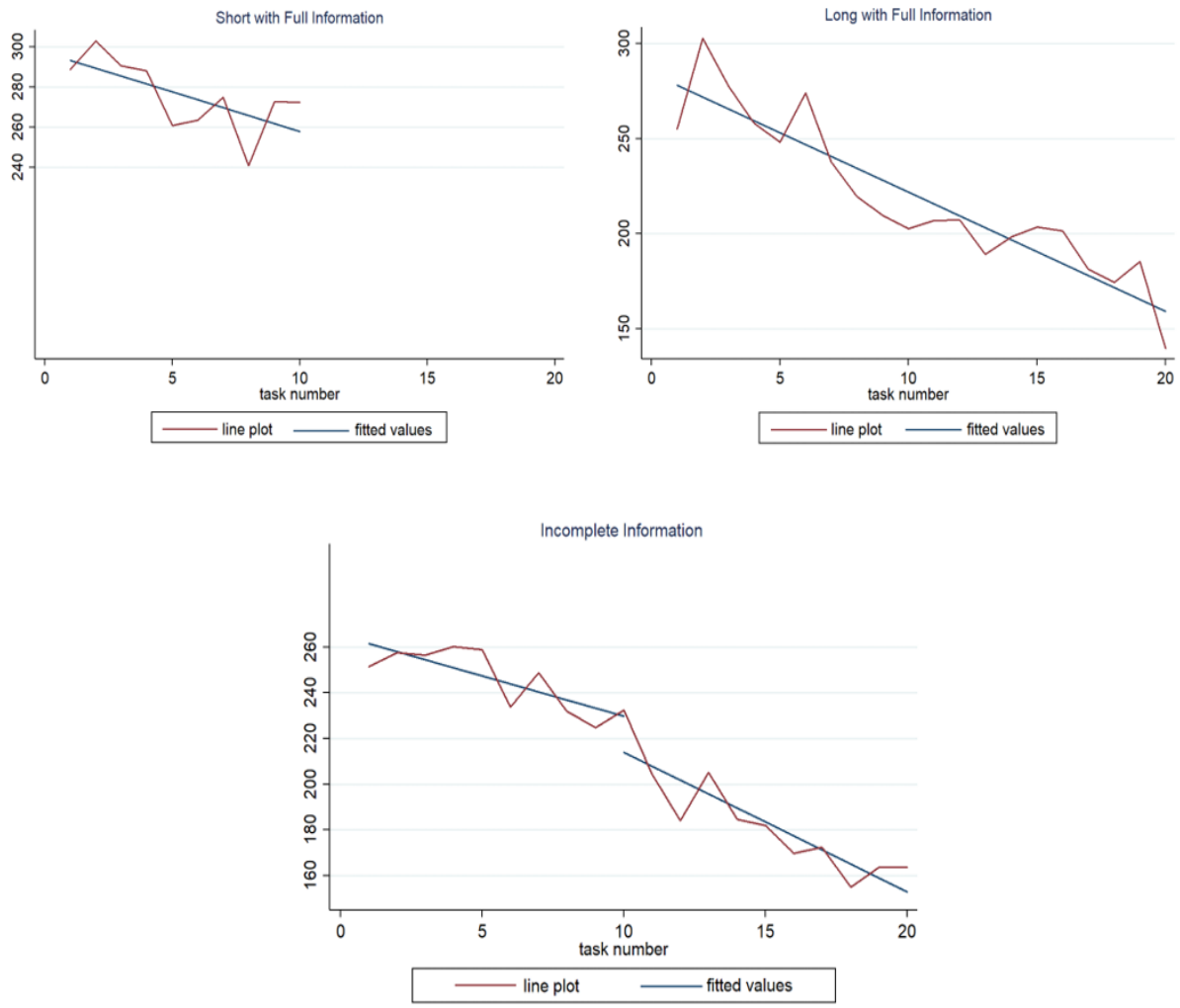

Figure 2: Average time spent on each task in numbers

The first and foremost candidate for possible explanation is present bias. It could be that the present bias of individuals under different treatments is driving this result. However, that is not the case as the result remains the same even after controlling for present bias in regression analysis. Not just this, the coefficient on present bias is also statistically insignificant when any of the delay measures is regressed on information [16] and other controls which implies that present bias is not able to explain the delay here. A similar story holds for risk preference as well.

Another possible explanation for the insignificant effect of providing complete information regarding the time needed to complete the task on delay could be that the subjects with incomplete information start increasing their speed at a faster rate post-task 10. With the first extra task that appears post 10, the subjects learn that the tasks assigned lie between 11 to 20 and not 10 to 20 so they likely update their expected number of tasks to a higher number. When the 12^{th} task appears, they learn further and update expectations and speed accordingly. Thus, even in the absence of

[16]This implies that the model's prediction regarding present bias is not supported by the data

full information, the subjects learn along the way and catch up by increasing their speed fast enough to not let the performance get affected due to lack of complete information. The data supports this explanation[17]. The results from the theoretical model also support this explanation. Even in the classroom experiment, there is an effect of information provision in terms of reduced procrastination pre-mid term and not post-mid term. Learning is a possible explanation for this as well.

Hence, the paper offers an explanation for the lack of effect of information provision on procrastination but it doesn't provide an answer to what explains the procrastination that appears in the data which is an important question given the stark statistically significant negative relationship found between delay and performance. Thus, the results of the study beg for further exploration of factors explaining procrastination. Also, the direct observation of procrastination in the lab used in this study offers a method to answer a lot of other questions pertaining to procrastination.

References

[1] David Ackerman and Barbara Gross. "My Instructor Made Me Do It: Task Characteristics of Procrastination". In: *Journal of Marketing Education - J Market Educ* 27 (Apr. 2005), pp. 5–13. DOI: 10.1177/0273475304273842.

[2] George A Akerlof. "Procrastination and Obedience". In: *American Economic Review* 81.2 (May 1991), pp. 1–19. URL: https://ideas.repec.org/a/aea/aecrev/v81y1991i2p1-19.html.

[3] William J. Knaus Albert Ellis. *Overcoming procrastination or how to think and act rationally in spite of life's inevitable hassles*. Institute for Rational Living, 1977.

[4] Dan Ariely and Klaus Wertenbroch. "Procrastination, Deadlines, and Performance: Self-Control by Precommitment". In: *Psychological Science* 13.3 (2002), pp. 219–224. ISSN: 09567976, 14679280. URL: http://www.jstor.org/stable/40063710.

[5] Ned Augenblick, Muriel Niederle, and Charles Sprenger. " Working over Time: Dynamic Inconsistency in Real Effort Tasks". In: *The Quarterly Journal of Economics* 130.3 (May 2015), pp. 1067–1115. ISSN: 0033-5533. DOI: 10.1093/qje/qjv020. eprint: https://academic.oup.com/qje/article-pdf/130/3/1067/30637254/qjv020.pdf. URL: https://doi.org/10.1093/qje/qjv020.

[6] Gary S. Becker. "Crime and Punishment: An Economic Approach". In: *Journal of Political Economy* 76.2 (1968), pp. 169–217. ISSN: 00223808, 1537534X. URL: http://www.jstor.org/stable/1830482.

[7] Gery Beswick, Esther Rothblum, and Leon Mann. "Psychological antecedents of student procrastination". In: *Australian Psychologist* 23 (July 1988), pp. 207–217. DOI: 10.1080/00050068808255605.

[17] Fig 2 is suggestive of the evidence and the explanation is already given under the results section 3.3.

[8] Allan Blunt and Timothy Pychyl. "Task aversiveness and procrastination: A multi-dimensional approach to task aversiveness across stages of personal projects". In: *Personality and Individual Differences* 24 (Jan. 2000), pp. 153–167. DOI: 10.1016/S0191-8869(99)00091-4.

[9] Zachary Breig, Matthew Gibson, and Jeffrey Shrader. "Why Do We Procrastinate? Present Bias and Optimism". In: *SSRN Electronic Journal* (Jan. 2019). DOI: 10.2139/ssrn.3445511.

[10] Jane B. Burka and Lenora M. Yuen. "Procrastination: Why You Do It, What To Do About It". In: 1983.

[11] Daniel L. Chen, Martin Schonger, and Chris Wickens. "oTree—An open-source platform for laboratory, online, and field experiments". In: *Journal of Behavioral and Experimental Finance* 9 (2016), pp. 88–97. ISSN: 2214-6350. DOI: https://doi.org/10.1016/j.jbef.2015.12.001. URL: https://www.sciencedirect.com/science/article/pii/S2214635016000101.

[12] Duru Erdinç and Murat Balkis. "Procrastination, self-esteem, academic performance, and well-being: A moderated mediation model". In: *International Journal of Educational Psychology* 6 (June 2017), p. 97. DOI: 10.17583/ijep.2017.2584.

[13] Joseph R Ferrari. "Self-handicapping by procrastinators: Protecting self-esteem, social-esteem, or both?" In: *Journal of Research in Personality* 25.3 (1991), pp. 245–261. ISSN: 0092-6566. DOI: https://doi.org/10.1016/0092-6566(91)90018-L. URL: https://www.sciencedirect.com/science/article/pii/009265669190018L.

[14] Joseph R. Ferrari. "Christmas and procrastination: Explaining lack of diligence at a "real-world" task deadline". In: *Personality and Individual Differences* 14.1 (1993), pp. 25–33. ISSN: 0191-8869. DOI: https://doi.org/10.1016/0191-8869(93)90171-X. URL: https://www.sciencedirect.com/science/article/pii/019188699390171X.

[15] Michael Frakes and Melissa Wasserman. "Procrastination in the Workplace: Evidence from the U.S. Patent Office". In: *SSRN Electronic Journal* (Jan. 2016). DOI: 10.2139/ssrn.2888061.

[16] Charles A. Holt and Susan K. Laury. "Risk Aversion and Incentive Effects". In: *American Economic Review* 92.5 (Dec. 2002), pp. 1644–1655. DOI: 10.1257/000282802762024700. URL: https://www.aeaweb.org/articles?id=10.1257/000282802762024700.

[17] Johannes Hoppe, Bastian Preissler, and Katrin Förster. "A Cross-Lagged Panel Design on the Causal Relationship of Task Ambiguity and State Procrastination: A Preliminary Investigation". In: *North American Journal of Psychology* 20 (May 2018).

[18] Johannes Hoppe, Renate Rau, and Philipp Prokop. "Empower, not impose!—Preventing academic procrastination". In: *Journal of Prevention Intervention Community* 46 (Feb. 2018), pp. 184–198. DOI: 10.1080/10852352.2016.1198172.

[19] Asad Islam et al. "Determining the Extent of Taste-Based and Statistical Discrimination:Evidence from a Field Experiment in India". Working paper. Feb. 2021.

[20] Ahmad Kader. "Academic Procrastination and Student Achievement in an Introductory Economics Course". In: *SSRN Electronic Journal* (Jan. 2014). DOI: 10.2139/ssrn.2404767.

[21] Katrin Klingsieck. "Procrastination When Good Things Don't Come to Those Who Wait". In: *European Psychologist* 18 (Jan. 2013), p. 24. DOI: 10.1027/1016-9040/a000138.

[22] Clarry Lay and Stuart Silverman. "Trait procrastination, anxiety, and dilatory behavior". In: *Personality and Individual Differences* 21.1 (1996), pp. 61–67. ISSN: 0191-8869. DOI: https://doi.org/10.1016/0191-8869(96)00038-4. URL: https://www.sciencedirect.com/science/article/pii/0191886996000384.

[23] Clarry H Lay. "At last, my research article on procrastination". In: *Journal of Research in Personality* 20.4 (1986), pp. 474–495. ISSN: 0092-6566. DOI: https://doi.org/10.1016/0092-6566(86)90127-3. URL: https://www.sciencedirect.com/science/article/pii/0092656686901273.

[24] Alison Legood et al. "From self-defeating to other defeating: Examining the effects of leader procrastination on follower work outcomes". In: *Journal of Occupational and Organizational Psychology* 91 (Feb. 2018). DOI: 10.1111/joop.12205.

[25] Jayson L. Lusk, Jutta Roosen, and Andrea Bieberstein. "Consumer Acceptance of New Food Technologies: Causes and Roots of Controversies". In: *Annual Review of Resource Economics* 6.1 (2014), pp. 381–405. DOI: 10.1146/annurev-resource-100913-012735. URL: https://doi.org/10.1146/annurev-resource-100913-012735.

[26] Ted O'Donoghue and Matthew Rabin. "Doing It Now or Later". In: *American Economic Review* 89.1 (Mar. 1999), pp. 103–124. DOI: 10.1257/aer.89.1.103. URL: https://www.aeaweb.org/articles?id=10.1257/aer.89.1.103.

[27] Miraj Shaima. "Coronavirus Disease 2019: The Public Health Challenge and Our Preparedness." In: *Bioscience Biotechnology Research Communications* 13.2 (2020), pp. 361–364. URL: http://dx.doi.org/10.21786/bbrc/13.2/1.

[28] Maury Silver and John Sabini. "Procrastinating". In: *Journal for the Theory of Social Behaviour* 11.2 (1981), pp. 207–221. DOI: 10.1111/j.1468-5914.1981.tb00033.x.

[29] Fuschia Sirois. "Procrastination and intentions to perform health behaviors: The role of self-efficacy and the consideration of future consequences". In: *Personality and Individual Differences* 37 (Jan. 2004), pp. 115–128. DOI: 10.1016/j.paid.2003.08.005.

[30] Piers Steel. "The nature of procrastination: a meta-analytic and theoretical review of quintessential self-regulatory failure. Psychol Bull 133: 65-94". In: *Psychological bulletin* 133 (Feb. 2007), pp. 65–94. DOI: 10.1037/0033-2909.133.1.65.

[31] Piers Steel, Thomas Brothen, and Catherine Wambach. "Procrastination and personality, performance, and mood". In: *Personality and Individual Differences* 30 (Jan. 2001), pp. 95–106. DOI: 10.1016/S0191-8869(00)00013-1.

[32] J. C. Wesley. "Effects of ability, high school achievement, and procrastinatory behavior on college performance". In: *Educational and Psychological Measurement* 54 (Jan. 1994), pp. 404–408. DOI: 10.1177/0013164494054002014.

[33] Lena Wieland et al. "Task ambiguity and academic procrastination: An experience sampling approach". In: *Learning and Instruction* 81 (Mar. 2022), p. 101595. DOI: 10.1016/j.learninstruc.2022.101595.