Washington University in St. Louis
Social Policy Institute

Increasing Successful Completion of Practical Engineering Diploma Programs

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About This Initiative

This research brief is part of a series by the Social Impact Nudgeathon initiative. This initiative incorporated insights from behavioral economics into the design and delivery of social welfare programs. Developed through a partnership between the Joint Distribution Committee (JDC) and the Social Policy Institute (SPI) at Washington University in St. Louis, this initiative is among the first of its kind to launch in Israel.

Working in close collaboration, research teams from the United States and Israel investigated whether using behavioral insights to make small changes in the delivery of social service programs in Israel and Russia would positively influence the outcomes of those programs.

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Initiative Supported By:

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Findings

- This brief summarizes the results from an experiment that focused on increasing the percentage of college students who submitted and successfully defended their final projects and thus were eligible to earn a professional degree from a technical college.
- The experiment focused on three study fields: architecture, electrical engineering, and software engineering.
- In the study, a random group of college departments introduced pre-specified deadlines for the final project submission and defense, as well as sent students personalized text messages that provided reminders, encouragements, and additional information on the benefits of completing program requirements in a timely manner.
- Study findings show that within the six months from final exams, our intervention increased the probability of successful completion of student projects—and thus the rates of graduation with technical college degrees—by approximately 30%.

Background

Non-academic, post-secondary education—typically referred to as vocational education and training—has been shown to improve young adults' labor market participation and employment outcomes (see e.g., Belfield & Bailey, 2017; Böckerman et al., 2019; Jepsen et al., 2014). In recent years, policymakers worldwide have responded to the call to improve the content of vocational education and training. This is demonstrated in the Bruges Communiqué, which is the European Union's 2020 roadmap for improving vocational education and training in Europe. Moreover, the Bruges Communiqué treats practical work-oriented vocational skills and academic qualifications as equally important (Brunello & Rocco, 2015).

In Israel, young adults can earn a practical engineer diploma, which is a professional degree awarded by technical colleges.[1] Despite the existence of this unique studies track, the training of practical engineers, and vocational education more generally, has been identified as a root cause for the labor shortages in many sectors and occupations. One of the main reasons for this workforce shortage is the low graduation rate among technical colleges (Kuczera et al., 2018). In 2016, it was estimated that only 49% of students who enrolled in technical colleges completed their course of study and only 63% of those who completed all courses were eventually eligible to receive a practical engineer diploma. To address this problem, the Joint Distribution Committee in Israel (JDC-Israel) initiated a behavioral intervention aimed at increasing the rates at which students at technical colleges were completing their course of study and graduating with official diplomas. Further, to evaluate the effectiveness of the intervention, the behavioral intervention was implemented as a randomized controlled trial.

The training of practical engineers and technicians in Israel is administered and regulated by the National Institute for Technical Training (NITT, "Mahat" in Hebrew), which is within the Ministry of Economy. Currently, Israel has more than 70 technical colleges, offering approximately 50 fields of study. To graduate, students are required to pass standard exams, which are administered by NITT, and to submit a final project that demonstrates learned knowledge and applies practical skills. Based on surveys conducted by NITT, the final project was identified as the primary reason why many students fail to qualify for a diploma. Among students who were not eligible to receive a diploma, 57.4% completed all their internal and national exams but did not submit a final project or failed to defend it successfully. Notably, NITT surveyed program graduates and found the vast majority (79%) of those who did not receive a diploma expressed their willingness to complete this last task in order to receive a diploma (Ministry of the Economy, 2017).

This result suggests that students recognize the importance of obtaining the practical engineer diploma, possibly due to its value in the labor market. Given that the final project was identified as a central barrier to

obtaining a diploma, the intervention described in this brief focused on increasing the percentage of students who submitted and successfully defended their final project, thereby increasing the percentage of students who graduate with diplomas. Previous studies have shown that setting clear, well-organized deadlines can increase the timely submission of projects (Ariely et al., 2002). Accordingly, studies designed to improve students' educational achievement encourage students to set specific long-term goals and then list the intermediate steps required to achieve their goals (Morisano et al., 2010). These strategies are used to overcome *present bias*, which is the human tendency to focus on the here-and-now and value immediate rewards over long-term benefits. Clark et al. (2020) show that setting personal task-based goals increased the rates of college course completion more than performance-based goals. Because our setting did not allow the research team to manage personal goal setting, we modified this approach as appropriate to the context. The details of the modified approach are provided below.

Research Objectives

The primary aim of the project was to increase the number of students who completed their educational course of study and obtained a practical engineer diploma. To accomplish this, we sought to test the effectiveness of a strategy that combined date-setting with reminder messages to increase the percentage of technical college students who submit a successful final project and earn a diploma. Specifically, we wanted to test the effectiveness of setting a specific date well in advance of the final submission date combined with sending text message (SMS) reminders to students to motivate them to keep working on their projects. In addition to measuring the impact of the intervention on the rate of final project submissions, we also use school administrative data to estimate the intervention effect on the timing of project submissions and on the percentage of students who graduate with diplomas.

Experimental Design and Data

Study Intervention

To successfully graduate, students have to complete their final project, which requires them to first submit a project proposal. After completing their projects, students submit a "project book" and defend their projects to a professional committee, assigned by NITT.

To increase the rate of successful defenses, as initially designed, the intervention included three elements:

- First, to define progress toward submitting the final project, we set four to five intermediate goals with specific deadlines. Each of the intermediate goals was defined as a specific task that students were required to complete and present to their supervisor. Supervisors were expected to report each student's status regarding these intermediate goals before and after each deadline, using an online form provided by the research team.
- Second, we developed a series of personalized SMS text messages which included deadline reminders for each intermediate goal and feedback on a student's success or failure to meet those goals by the deadline. Because the structure of the final project varied by study field (i.e., major), the intermediate goals, as well as the planned SMS content and text schedule, were tailored to each major.
- Third, according to our instructions, NITT set deadline dates for the final project defense in advance. These dates were coordinated and communicated to students by their departments. This is in stark contrast with NITT's common practice of setting defense dates on a rolling basis. To enforce these deadlines, the participating departments were notified that they would have to wait for at least two months to reschedule a defense for students who will not be able to meet the pre-determined deadline.

In the process of implementing the planned intervention, the research team realized that NITT had limited capacity to gather data on students' status regarding their intermediate goals. In addition,

the research team discovered a wide variability of supervision practices across colleges, which made it impractical to impose identical schedules for students attending different colleges. Therefore, we altered the research design by omitting the first element (i.e., setting intermediate goals) but retained the second and third elements (i.e., personalized SMS text messages and setting a rigid deadline for final project submission, respectively). The departments in the treatment group were asked to set dates for the project defense well in advance and inform students of this strict deadline. Depending on the specific study field and on the preferences of the different departments, these deadlines were set three to six months in advance. The text messages were changed to eliminate references to the intermediate stages of the project and instead provided reminders, encouragements, and some information on the benefits of completing the final project in a timely manner. For an example of the content of these text messages, see Appendix (Figure A1).

Overall, seven rounds of SMS text messages were sent between April 2019 and January 2020. The first two messages encouraged students to submit a proposal for their final project. We only sent these messages to students who, based on the department heads' reports, had not yet submitted their proposal at the time. After the third message, we gradually stopped sending messages to students from the departments in which the pre-determined defense dates had already passed (according to the records in NITT). The last pre-determined defense dates were scheduled for February 2020.

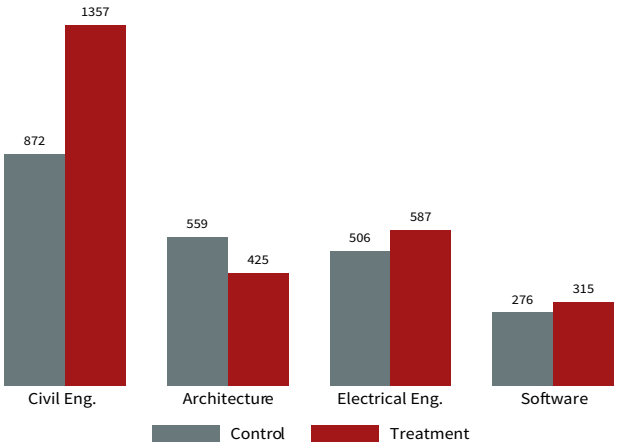
Data and Randomization

Study participants included 4,900 students from 89 departments in 33 technical colleges in Israel. Departments were randomly assigned to either the control group (43 departments; n = 2,215 students; 42.6%) or the experimental (treatment) group (46 departments; n = 2,685 students; 58.4%). The experiment focused on four study fields (i.e., majors): architecture, electrical engineering, civil engineering, and software engineering. Of these fields, licensure is required for architecture, electrical engineering, and civil engineering and graduation is a requirement to obtain such licensure. Students who fail to graduate are not able to obtain their professional license and are thus unable to perform important professional tasks and duties. This, in turn, limits their ability to pursue professional career tracks in their area of study.

Treatment was assigned using a pair-wise randomization procedure (Bruhn and McKenzie, 2009) in which departments from the same field of study were matched based on previous rates of graduation with a diploma, the target population of the college (Arab or not),[2] and the number of students. When the number of departments for a specific field of studies was uneven, we matched one triplet and assigned two units to the treatment group and one to the control group. Figure 1 presents the number of students in the treatment and control groups by major.

Although civil engineering students participated in the experiment, at the time of this writing, we are unable to report treatment effects for this major. This is because in this field of study, approximately 25% of students choose to continue their studies for one additional semester to receive a Construction Planning certificate and licensure. These students were not expected to complete their final projects within the period of our experiment. At the same time, looking only at the group of students who did not choose this prolonged track may yield biased estimates, since our treatment may have affected the selection of students into the construction planning track. Moreover, we did not yet obtain the required data to analyze this selection or to follow the outcomes of students enrolled in the prolonged track.

Figure 1: Number of Students in the Treatment & Control Groups, by Major



We use administrative individual-level data from NITT, which include information on final project proposal submission and defense dates, as well as the date of diploma eligibility (or graduation). These data also include basic demographic information, such as students' gender, age, and locality of residence. The locality of residence was used to assign a socioeconomic z-score for each student according to the Israeli Central Bureau of Statistics (CBS) classification of localities.[3] In addition, we draw on department-level data, which include information on the average rates of graduation with a diploma over the previous seven years and whether the college targets a specific demographic group (e.g., Arab Israelis).

Sample Characteristics

Table 1 presents summary statistics and balance tests on pre-intervention characteristics for the sample of three majors for which we estimate treatment effects in this brief: architecture, electrical engineering, and software engineering. In this sample, there are 2,668 students and 64 randomization units (departments).

Panel A reports individual-level characteristics and Panel B refers to the averages at the department level, which is our unit of randomization. As reported in Column 1 of Panel A, the average student in the control group is 26.9 years old and 34.8% of students in the control group are female.[4] We also present the average z-score of students' socioeconomic status, which is based on students' locality of residence. The negative mean indicates that, on average, students come from localities with socioeconomic scores below the country's mean.

Panel B reports that the average share of students who graduated with a diploma over the previous seven cohorts was only 43.47%. This is an interesting statistic as it indicates the necessity of our intervention. In addition, on average, there are approximately 43 students in each department and 854 students in each college. Almost 10% of departments in our sample are in colleges that target the Arab population. While these colleges uniquely cater to Arab students, it should be noted that there are many Arab students enrolled in other colleges as well.[5] Another important feature of technical colleges is that they offer an evening track for students who work during the day. Indeed, 71% of departments have an evening track and a similar share of departments have a morning track, indicating that many departments offer both options. Lastly, departments included in the experiment are within colleges that offer, on average, three out of four majors.

Column 2 presents the differences between the treatment and control groups within assignment pairs (or triplets). The differences are small and statistically insignificant for all observed characteristics, both at the individual and at the department level, and thus, we can conclude that the groups were similar pre-treatment.

To confirm this assertion, we also conduct a joint balance test, in which we regress an indicator for the treatment status on all observed pre-treatment characteristics, and report the results of the *F*-test for the model's ability to predict the outcome (i.e., treatment assignment). In this specification, we also add assignment pair (or triplet) fixed effects. The p-value for this test is reported at the bottom of each panel and is above 0.8 for both the individual and department level tests. The interpretation of this result is that the treatment status of a student or of a department cannot be inferred based on observable individual and department characteristics.

Table 1: Summary Statistics and Balance Tests

	(1) Control group mean	(2) Difference between treatment and control
Panel A – Individual level		
Female	0.348	0.003
		(0.011)
Age (years)	26.902	0.133
		(0.485)
Socioeconomic z-score	-0.023	(0.023)
		(0.09)
p-value for joint balance		0.88
Number of observations (students)		2,668
Panel B – Department level		
Graduation rate (%)	43.467	1.319
		(0.915)
Number of students in department	43.258	-3
		(2.877)
Number of students in college	854.48	-75.253
		(117.649)
Focus on Arab population	0.097	-0.021
		(0.021)
Morning track	0.71	-0.042
		(0.096)
Evening track	0.71	-0.074
		(0.118)
Number of majors offered by college (out of four participating majors)	3.194	-0.116
		(0.183)
p-value for joint balance		0.85
Number of observations (departments)		64

Notes: Standard errors in parentheses (clustered by department in Panel A and clustered by assignment pair in Panel B).

Empirical Method

As mentioned above, our intervention ended in February 2020, when the last pre-determined defense took place. The COVID-19 crisis started to impact the Israeli population in mid-March of 2020, when the first lockdown was declared. While some defenses took place online between March and May of 2020, according to our data, only 67 students in our sample defended their projects during this period (compared to almost 200 just in February 2020). Thus, the analysis presented in this brief only follows students until the end of March 2020.

We restructure the detailed, individual-level data as a panel dataset so that our three outcomes of interest are observed for each student in each month. The outcome variables are indicators for proposal submission, project defense, and graduation (1=yes; 0=no).

We estimate the following equation for these three outcome variables:

$$Y_{ipt} = \sum_{t=1}^{n} \beta_t \, d_t \times treated_{ip} + \delta_t + \gamma_p + \alpha' X_{ip} + \varepsilon_{ipt}$$

Where Y_{ipt} is the outcome of student *i* from assignment pair *p* in month *t*; $treated_{ip}$ indicates the treatment status of the individual; d_t is a dummy variable that is equal to 1 in month t (and zero otherwise); δ_t and Y_p are month and assignment pair fixed-effects, respectively; X_{ip} is a vector of individual, department, and college level characteristics for individual i in assignment pair p; and ε_{ipt} is the error term. Standard errors are clustered at the randomization unit level.

Therefore, β_t can be interpreted as the average difference in outcomes between treated and untreated students in month t, within assignment pair and conditional on observed characteristics. Because our outcomes are project submission, project defense, or graduation *by* month *t*, the estimated differences in each month are cumulative in the sense that they calculate the accumulated difference between treatment and control students, rather than the difference in the specific events in month t.

Results

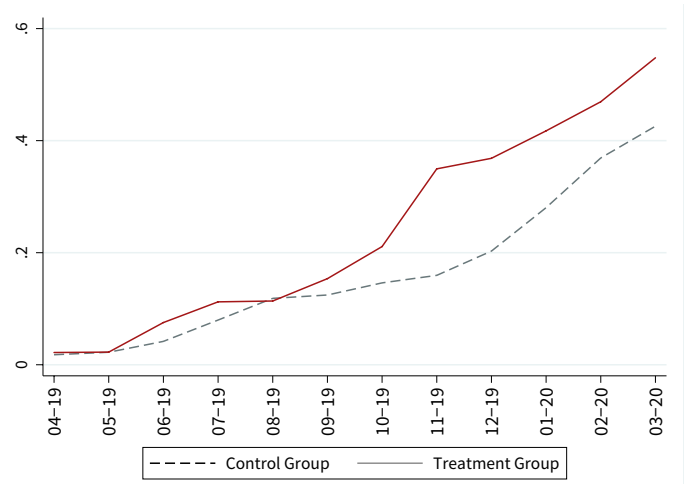
Figure 2 presents the raw data (Panel A) along with the results of the estimation described above (Panel B) for the main outcome of interest in this experiment—the defense of the final project by a certain date. First, on the left-hand side (Panel A), we plot the share of students who have successfully defended their projects by the end of each month, for the treatment and control groups. In April of 2019, this share is practically zero. Both groups show a moderate and steady increase in the project defense rate until August 2019, which is the month when students take their last exams. Starting in September 2019, the treatment group diverges from this steady trend and the gap between the groups increases sharply until November 2019. Afterward, despite an attenuation of this increase, a substantial difference between the two lines persists over time. By the end of March 2020, slightly more than 42% of students in the control group defended their projects, compared to about 55% of students in the treatment group.

When we estimate this difference in a regression model (Panel B), controlling for assignment pairs and background characteristics, the estimated treatment effect is 21.1 percentage points at its peak (in November 2019) and approximately 14.1 percentage points in March 2020. These differences are statistically significant, although standard errors are relatively large and the 95% confidence intervals for the effect in March of 2020 range between 3.8 and 24.4 percentage points.

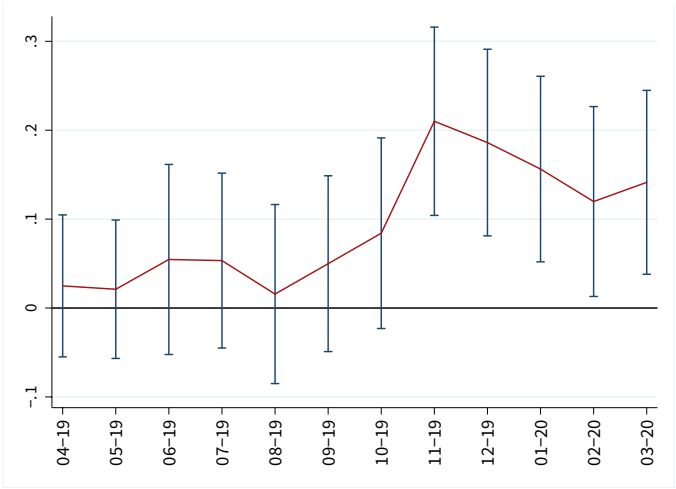
Figure A2 in the Appendix repeats the analysis for proposal submission, demonstrating a positive difference between the treatment and control groups, although the difference is not significant at conventional levels. This positive gap seems to appear first in July 2019, approximately four months before we start to observe a gap in project defense rates. This is in line with the average expected time for completion of the final project.

Figure 2: Treatment Effect, Final Project Defense Rates (by Month)

Panel A: Project Defense Over Time



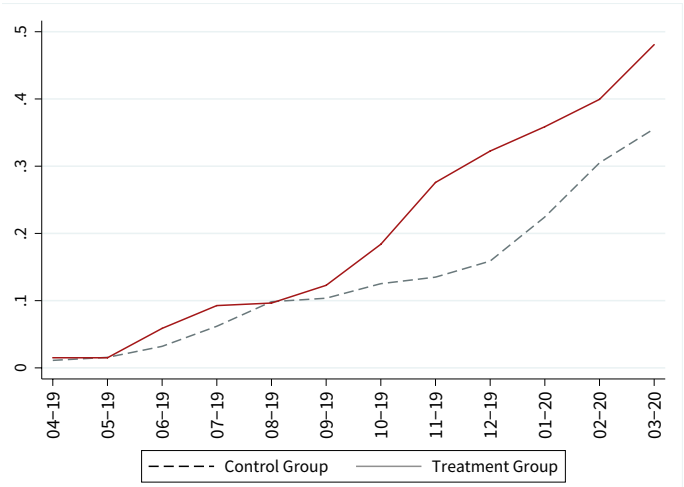
Panel B: Regression Estimates



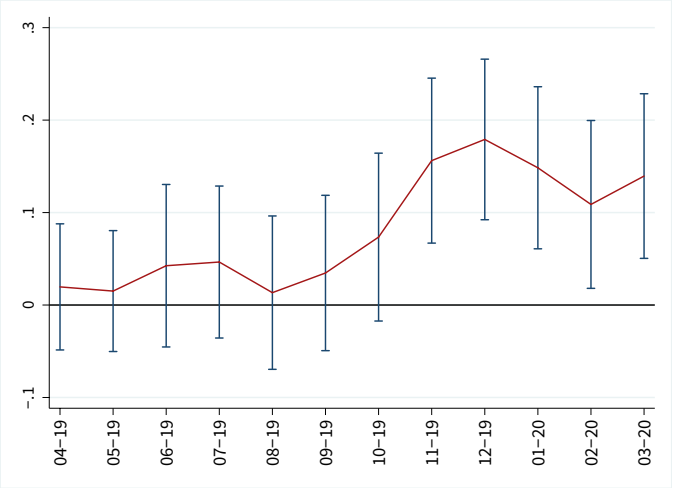
Notes: Vertical lines in Panel B correspond to 95% confidence intervals.

Figure 3: Treatment Effect, Graduation Rates (by Month)

Panel A: Graduation Rates Over Time



Panel B: Regression Estimates



Notes: Vertical lines in Panel B correspond to 95% confidence intervals.

Figure 3 presents the results for graduation (or diploma eligibility). The pattern is very similar to the one found for final project defense, except that the share of students who graduated with a diploma in both groups is lower than the rate of successful defenses. This is reasonable because the final project is only one of the requirements that a student has to meet to be eligible for a diploma. For example, some students may still need to complete courses or retake tests in order to graduate and be eligible for a diploma. Notably, Panel A shows that in March 2020, the share of students who graduated in the control group is approximately eight percentage points lower than the average graduation rate for the same departments in previous years (as

reported in Table 1), while the point estimate of the treatment effect is much larger (almost 14 percentage points, in Panel B). Assuming that the past rates are similar to the current cohort's expected graduation rates (in the absence of treatment), this may suggest that even if no additional students in the treatment group will be eligible for diplomas after March 2020, the control group will end up having a rate of graduation six percentage points lower than that of the treatment.

Further, Figure A3 in the Appendix shows that the treatment effects are relatively similar across different majors, confirming that the results are not driven by a specific study field. Lastly, as shown in Figures A4 in the Appendix, the results are also robust across gender, although confidence intervals are larger for women due to a relatively small sample size.

Conclusion

Overall, the results presented here demonstrate that setting deadlines in advance and sending SMS text reminders and encouragements increased the probability of successful completion of student projects, thereby increasing the rates of graduation with diplomas. More broadly, these findings indicate that a pre-determined end date for a lengthy and demanding assignment may substantially increase the likelihood of its completion. To test for the persistence of the positive impact we find in our study, we plan to follow this cohort of students over time. Although it is plausible that our intervention pushed some students to complete their final project who may not have done so otherwise, it may also be the case that these students merely completed the project earlier. If the latter is true, we should see a convergence of project defense and graduation rates among the treatment and control groups over time. We note that even if this is the case, the fact that the intervention led students to enter the labor market earlier could positively impact their labor market outcomes.

Endnotes

1. Although the length of coursework varies by field, it typically takes two to three years to complete the training.
2. Colleges that target the Ultra-Orthodox population did not participate in our experiment because this population tends to hold "Kosher" cell phones that disable SMS text messages, and because the initial rates of final project submission were very high in these colleges, with little room for improvement.
3. We use the Israeli CBS Socioeconomic rank of localities in 2013, which combines 14 locality-level characteristics that represent the demographic composition of the population in the locality, educational levels, standard of living measures, and employment and benefit collection patterns.
4. Most of the female students were majoring in architecture, constituting 78.5% of architecture students.
5. Unfortunately, our data only partially identify religion at the individual level, which otherwise would be the best indicator to determine religion/ethnicity of a student. Hence, we are not able to report the share of Arab students in "non-Arab" colleges.

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Disclaimer

This research brief reflects research work conducted by the authors, and does not necessarily represent the views or opinions of the JDC-Israel or the Government of Israel. The authors accept full responsibility for errors or omissions.

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Appendix

Figure A1: Examples of SMS Text Messages

Text Message Example 1:

"Hello <first name>,

Did you know that NITT students who complete their final project and receive a diploma receive better job offers?

Your holiday vacation is a good time to make progress on your final project.

Happy Passover ☺

Avivit Alfasi,

Final Project Director at NITT."

Text Message Example 2:

"Hello <first name>,

Your final exams are over and now it is time to complete your final project!

The best companies are looking for graduates with a diploma. With a little bit of effort, you can earn a job with one of the best companies in your field.

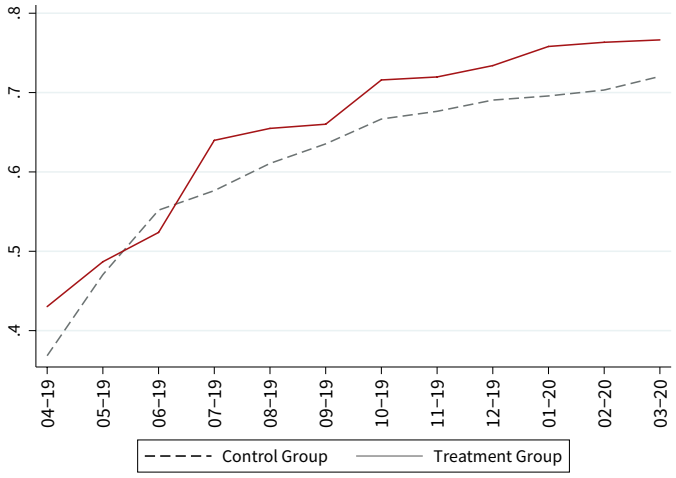
See you at the finish line! ☺

Avivit Alfasi,

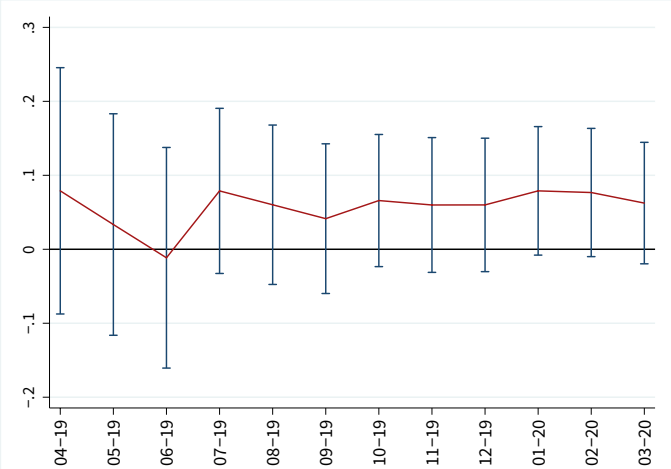
Final Project Director at NITT."

Figure A2: Treatment Effect, Proposal Submission Rates (by Month)

Panel A: Proposal Submission Over Time



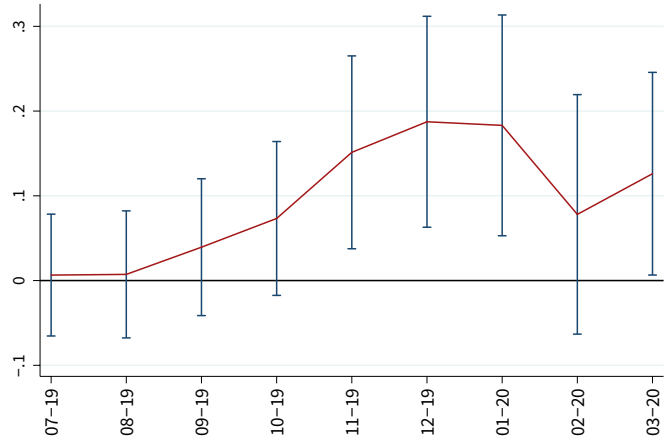
Panel B: Regression Estimates



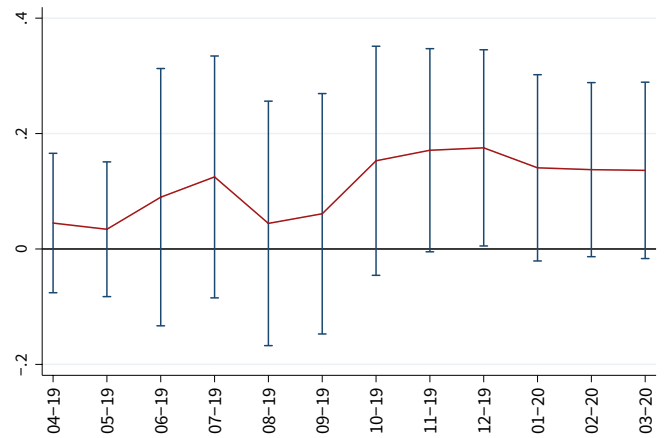
Notes: Vertical lines in Panel B correspond to 95% confidence intervals.

Figure A3: Treatment Effect, Graduation Rates, Regression Estimates by Major

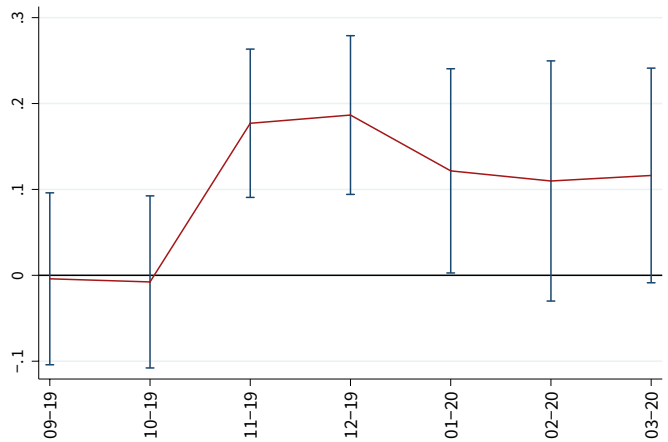
Panel A: Electrical Engineering



Panel B: Architecture



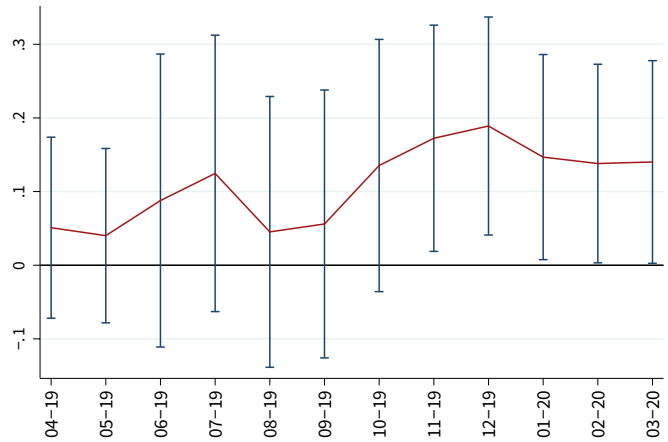
Panel C: Software Engineering



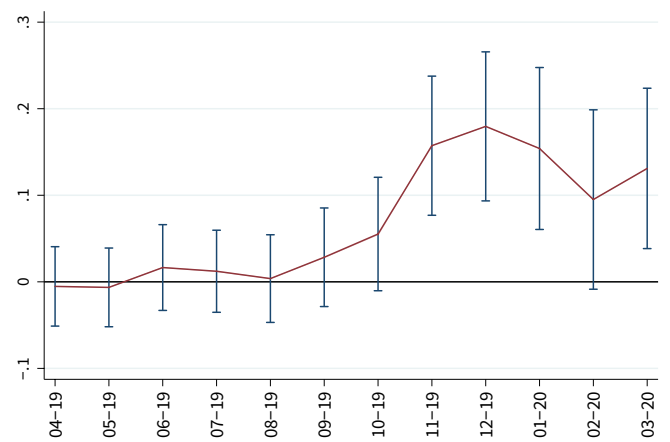
Notes: Vertical lines correspond to 95% confidence intervals.

Figure A4: Treatment Effect, Graduation Rates, Regression Estimates by Gender

Panel A: Female



Panel B: Male



Notes: Vertical lines correspond to 95% confidence intervals.