Returns to University Courses

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[Very Preliminary Draft]

Abstract

Education is one of the most important determinants of wages at the individual level. However, there is much debate about the mechanisms by which education leads to higher wages. In this paper, I study the returns to taking particular courses and developing specific human capital at the university level. National University of Singapore (NUS) provides a unique setting in which students bid to take courses each semester. I exploit a regression discontinuity design (RDD) to quantify the impact of taking specific courses. Specifically, close to the thresholds that determine a winning bid, individuals with very similar bids may be enrolled or turned away from taking the course. I find that learning a second language increases monthly gross income by about 300 USD. Taking statistics elective courses increases monthly gross income by about 650 USD. I also find evidence for positive income returns to Computer Science related electives, and Finance. I don't find significant returns for elective courses offered by general science or humanities departments. In future work, I will look at occupational choice outcomes, and am planning to implement an RCT where we nudge a treatment group of students to take particular STEM courses via an information intervention.

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1 Introduction

Education is one of the most important determinants of wages at the individual level. However, there is much debate about the mechanisms by which education leads to higher wages. Even conditional on attending, post-college earnings for graduates vary widely. There is a rich literature studying returns to education by field of study, surveyed by Altonji, Blom, and Meghir (2012), but to my knowledge no work looking at the returns to specific university-level courses.

In this paper, I study the returns to taking particular courses and developing specific human capital at the university level. National University of Singapore (NUS) provides a unique setting in which students bid to take courses each semester. I exploit a regression discontinuity design (RDD) to quantify the impact of taking specific courses. Specifically, close to the thresholds that determine a winning bid, individuals with very similar bids may be enrolled or turned away from taking the course. I find that learning a second language increases monthly gross income by about 300 USD. Taking statistics elective courses increases monthly gross income by about 650 USD. I also find evidence for positive income returns to Computer Science related electives, and Finance. I don't find significant returns for elective courses offered by general science or humanities departments.

These results have important implications for policy. If taking certain courses results in higher earnings for graduates, policymakers should expand and encourage students to invest in these courses. In future work, I will look at occupational choice outcomes, and am planning to implement an RCT where we nudge a treatment group of students to take particular STEM courses via an information intervention.

2 Background and Data

Our data is drawn from administrative records of seven cohorts of graduates from NUS merged with their labor market information from employment surveys conducted by the

university roughly six months after graduation. The Graduate Employment Survey (GES) asks students about their salary, job search experience since graduation, and various information (e.g., sector, industry, full- or part-time) about their current job. All public universities in Singapore participate in the survey and have to ensure that the sampling is representative of the graduating population and that the response rate reaches at least 70 percent. Comparing the means of key covariates shows that the merged survey sample is generally comparable to the sample of admin data (all NUS graduates).

In 2018, Singapore's resident labor force was 2.3 million, in which approximately 36.7% held a university degree. The graduating cohort in 2017 is about 16,160 and the vast majority are from six publicly funded universities in Singapore. Among these institutions, NUS, where our sample is drawn from, is the largest university and accounts for about 44% of the annual intake of undergraduates each year since the mid-2000.4 The next largest university, the Nanyang Technological University (NTU) accounts for about 41% of the annual intake.

Each semester, students receive 1000 points that can be used to bid for their desired courses which rolls over semester to semester. Major requirements are allocated to students, so the bidding only applies to non-required courses.

3 Estimation Strategy

Our regression discontinuity design (RDD) compares the salaries of students that bid greater than the winning bid threshold by a small margin with those that bid under by a small margin. The intuition is that students who bid just above and below the winning bid amount are similar in terms of their characteristics; however, bidding just above the threshold would increase the probability that a student takes the course that they bid for. Note that students can bid to take a course in subsequent semesters if they fail to bid sufficiently high in a given semester. By comparing the labor market outcomes of students just above and just below the bidding threshold, we can estimate the returns to taking this university course. This

design will distinguish the effect of taking a course from other confounding factors as long as the determinants of job salaries (e.g., motivation, family support) are continuous at the grade cutoff. Under this assumption, any discontinuous jump in earnings at the winning bid cutoff can be interpreted as the causal effect of the course.

We will use local polynomial regressions as the main empirical specification, as suggested by Gelman and Imbens (2018). The optimal bandwidth used in our baseline RD estimates is based on the method developed by Calonico et al. (2014).

4 Results

4.1 First Stage: Effects on Course Enrollment

We first examine whether bidding above the winning bid amount affects the likelihood of ever enrolling in the course. Figure 1 plots the relationship between the distance of a student's bid amount to the winning bid and the probability of ever enrolling in the course. Figure 10 plots the relationship between the bid amount and the probability of ever enrolling in the course for a single example course (bid threshold in red).

4.2 Non-random Selection around the CAP Threshold

A key identifying assumption is that, absence the treatment (enrolling in the course), the average outcomes (wages) of the individuals would be smooth in the running variable (bid). As discussed by Lee (2008), it implies that individuals cannot fully manipulate the running variable, distance from the winning bid. A standard test of manipulation is to check the density of the running variable (McCrary, 2008). Figure 2 plots the density of student bids for a single example course. We don't find bunching around the winning bid.

We also show that demographics and ability are smooth across the winning bid threshold. Figure 11 plots the relationship between gender and the distance from winning bid. Figure 3 plots the relationship between Cumulative Average Point, a proxy for ability, and the

Figure 1: First Stage - Pooled

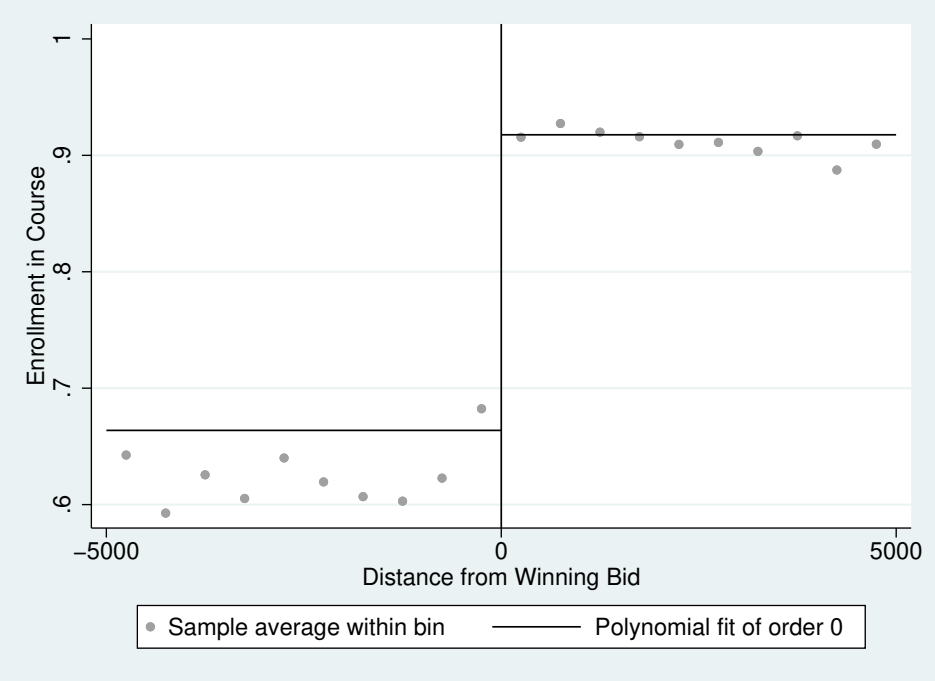

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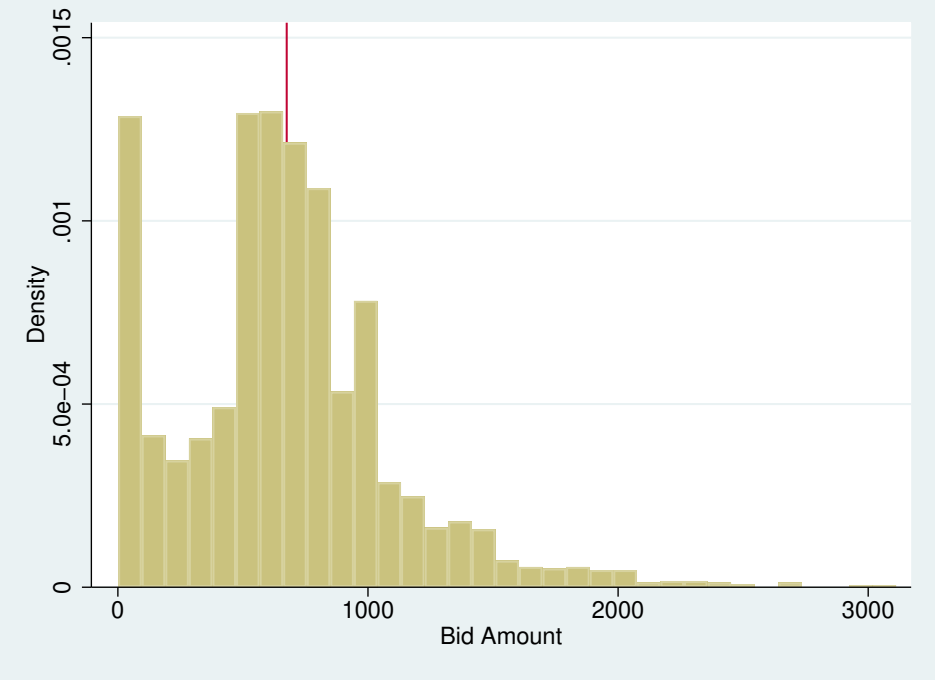
Figure 2: Manipulation Check



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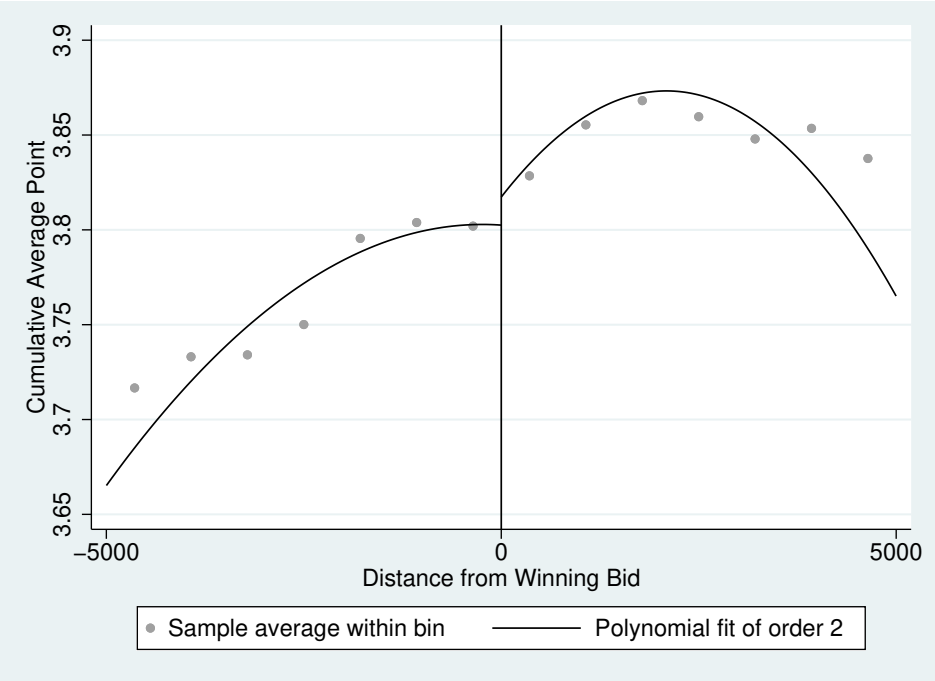
distance from winning bid.

Figure 3: Continuity of Predetermined Variables: Cumulative Point Average



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4.3 Returns to Second Language Courses

First, I study the returns to taking second language courses. Students at NUS have the option to bid and enroll in second language courses outside their required courses for their major. The languages offered are Arabic, Bahasa Indonesia, Chinese (Mandarin), French, German, Hindi, Japanese, Korean, Malay, Spanish, Tamil, Thai and Vietnamese. Acquiring language skills may be valuable in the labor market given the global nature of the economy.

Figure 4 shows the first stage effect of bidding above the winning bid threshold on enrollment for second language courses. Figure 5 plots the plots the "reduced-form" relationship between earnings and distance to winning bid threshold for second language courses.

The above results include both introductory and advanced language courses. Now, we focus on the returns to starting a second language by fousing on introductory courses. Figure

7 shows the first stage effect of bidding above the winning bid threshold on enrollment. Figure 5 plots the plots the "reduced-form" relationship between earnings and distance to winning bid threshold for introductory second language courses.

Figure 4: First Stage – Language Courses

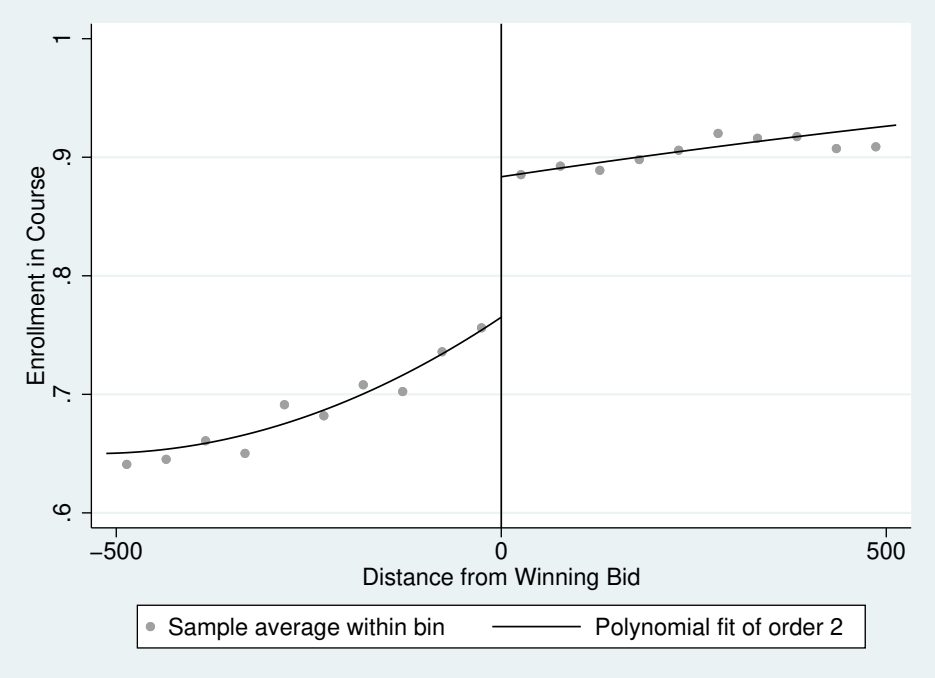

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Table 1 reports the regression results. We estimate that return to taking language courses is 480 Singapore dollars in gross monthly income. We estimate that return to taking intro language courses is 500 Singapore dollars in gross monthly income.

Figure 5: Returns to Language Courses

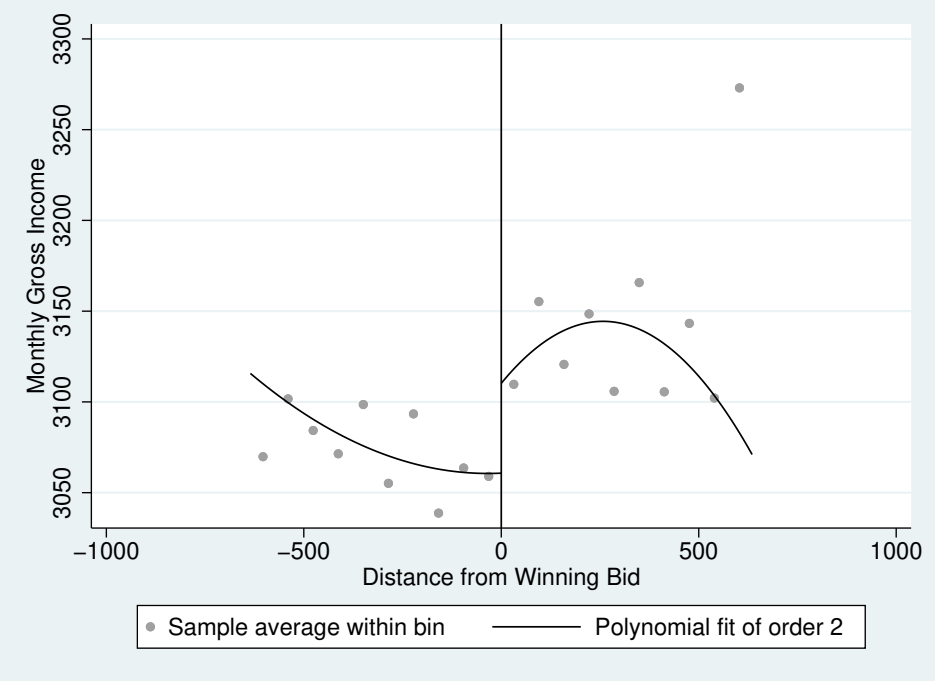

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Figure 6: First Stage – Introductory Language Courses

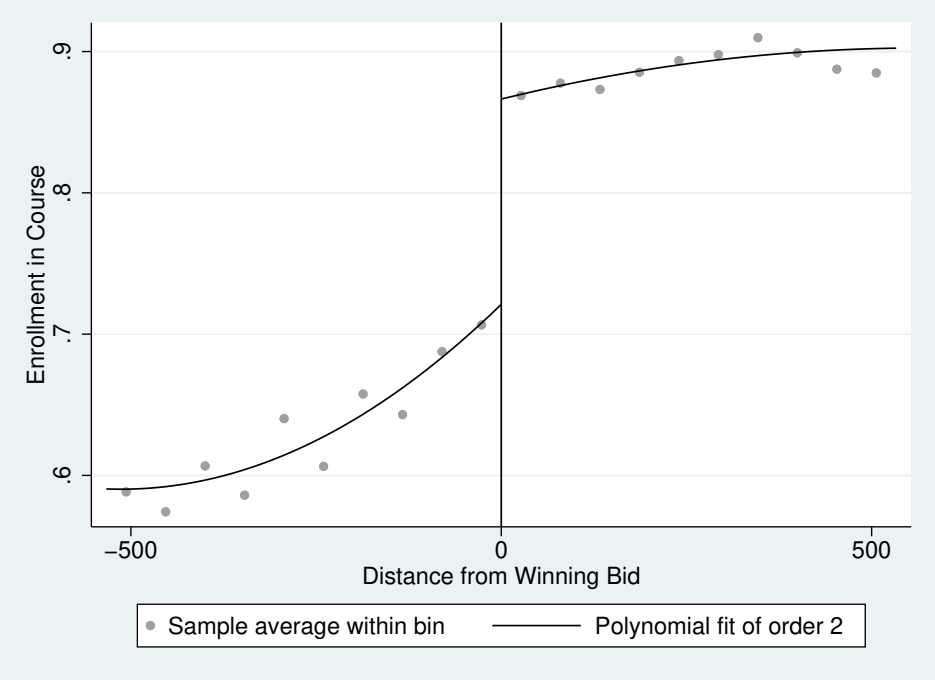

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Figure 7: Returns to Introductory Language Courses

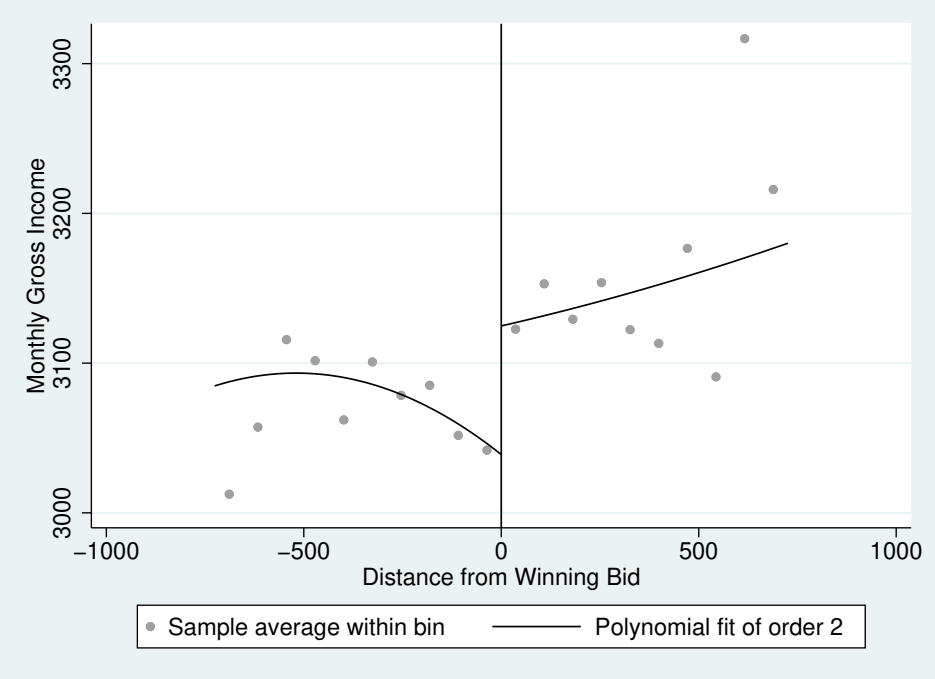

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Table 1: Returns to Language Courses

	(1) Enrollment	(2) Income	(3) Income	(4) Enrollment	(5) Income	(6) Income	(7) Income	(8) Income
RD_Estimate	0.118***	59.667**	371.342*	0.145***	85.907***	480.714**	498.056***	431.448**
	[0.007]	[25.744]	[206.128]	[0.008]	[30.767]	[188.605]	[182.031]	[170.847]
Robust 95% CI	[.102 ; .131]	[1.894 ; 111.038]	[-80.905 ; 779.452]	[.125 ; .161]	[17.765 ; 149.082]	[115.789 ; 888.318]	[146 ; 888.918]	[105.08 ; 824.266]
Kernel Type	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular
BW Type	mserd	mserd	mserd	mserd	mserd	mserd	mserd	mserd
Observations	89770	32529	32529	67940	24626	24626	24626	24626
Conventional Std. Error	0.007	25.744	206.128	0.008	30.767	188.605	182.031	170.847
Conventional p-value	0.000	0.020	0.072	0.000	0.005	0.011	0.006	0.012
Robust p-value	0.000	0.043	0.112	0.000	0.013	0.011	0.006	0.011
Order Loc. Poly. (p)	2.000	2.000	2.000	2.000	2.000	2.000	2.000	1.000
Order Bias (q)	3.000	3.000	3.000	3.000	3.000	3.000	3.000	2.000
BW Loc. Poly. (h)	512.896	770.875	635.164	533.148	725.794	682.395	749.808	345.204
BW Bias (b)	898.630	1101.120	994.124	847.566	1009.577	1273.465	1481.004	763.040
Model	Sharp	Sharp	Fuzzy	Sharp	Sharp	Fuzzy	Fuzzy	Fuzzy
Sample	All	All	All	Introductory	Introductory	Introductory	Introductory	Introductory
Demo. Control							X	X

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in brackets.

4.4 Returns to Statistics

NUS undergraduate students have to fulfil 20 Modular Credits (or 5 courses) of General Education requirements. These requirements usually are completed in the first few terms. Post-graduate jobs are valuing quantitative skills such as statistics, data analytics and programming more and more. STEM-related jobs grew at three times the rate of non-STEM jobs between 2000 and 2010. I study the return to taking the Statistics and Applied Probability course as a General requirement in this section, then look at General Education Computer Science/Computing courses later. This general education statistics course is popular among student in a non-STEM field hoping to develop statistical or quantitative tools for the job market. The course description reads: The student will learn practical skills in interpreting statistical information and gain the ability to critically evaluate statistically based arguments.

Figure 12 shows the first stage effect of bidding above the winning bid threshold on enrollment. Figure 13 plots the plots the "reduced-form" relationship between earnings and distance to winning bid threshold.

Table 2 reports the regression results. We estimate that return to taking language courses is 880 Singapore dollars in gross monthly income.

4.5 Returns to Finance and CS

Some of the most high paying jobs in the economy today are in the finance or technology industry. NUS offers courses for students outside of the Computer Science or Business Departments hoping to develop knowledge and skills specific to these industries. In this section, I study the returns to taking the core Finance Course for non-Business majors, the Introduction to Computer Science course for General Science majors, the Introduction to Computer Science course for Non-CS Engineering majors, and general education courses offered by the Computer Science Department.

We find evidence that there are returns to taking Finance, and general education courses

Table 2: Returns to Statistics

	(1) Enrollment	(2) Income	(3) Income	(4) Income	(5) Income
RD_Estimate	0.195***	138.821**	1020.255**	957.931**	880.475**
	[0.016]	[59.409]	[466.896]	[433.618]	[381.850]
Robust 95% CI	[.157 ; .227]	[20.82 ; 273.957]	[106.402 ; 2068.012]	[84.209 ; 1892.013]	[113.146 ; 1852.835]
Kernel Type	Triangular	Triangular	Triangular	Triangular	Triangular
BW Type	mserd	mserd	mserd	mserd	mserd
Observations	18872	8841	8841	8841	8841
Conventional Std. Error	0.016	59.409	466.896	433.618	381.850
Conventional p-value	0.000	0.019	0.029	0.027	0.021
Robust p-value	0.000	0.022	0.030	0.032	0.027
Order Loc. Poly. (p)	2.000	2.000	2.000	2.000	1.000
Order Bias (q)	3.000	3.000	3.000	3.000	2.000
BW Loc. Poly. (h)	430.323	466.501	482.439	563.669	284.124
BW Bias (b)	732.358	771.351	875.529	1024.613	546.960
Model	Sharp	Sharp	Fuzzy	Fuzzy	Fuzzy
Demo. Control				X	X

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in brackets.

offered by the CS department, but not Introduction to Computer Science for Science and Engineering majors. Table 3 reports the regression results.

Table 3: Returns to Finance and CS

	(1) Income	(2) Income	(3) Income	(4) Income
RD_Estimate	377.123*	−116.914	−395.910	228.487**
	[211.951]	[213.922]	[274.190]	[102.555]
Robust 95% CI	[13.734 ; 887.51]	[-574.884 ; 393.9]	[-1042.522 ; 133.118]	[40.699 ; 471.787]
Kernel Type	Triangular	Triangular	Triangular	Triangular
BW Type	mserd	mserd	mserd	mserd
Observations	395	1094	794	3672
Conventional Std. Error	211.951	213.922	274.190	102.555
Conventional p-value	0.075	0.585	0.149	0.026
Robust p-value	0.043	0.714	0.129	0.020
Order Loc. Poly. (p)	2.000	2.000	2.000	2.000
Order Bias (q)	3.000	3.000	3.000	3.000
BW Loc. Poly. (h)	305.155	669.828	423.416	355.545
BW Bias (b)	515.225	907.123	684.751	535.584
Course	Finance	CS (Engineering)	CS (Science)	CS (Elective)
Demo. Control	X	X	X	X

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in brackets.

Figure 8 shows the positive effect of taking Finance. Figure 9 shows the null effect of taking Introduction to Computer Science.

Figure 8: Postive Returns to Finance

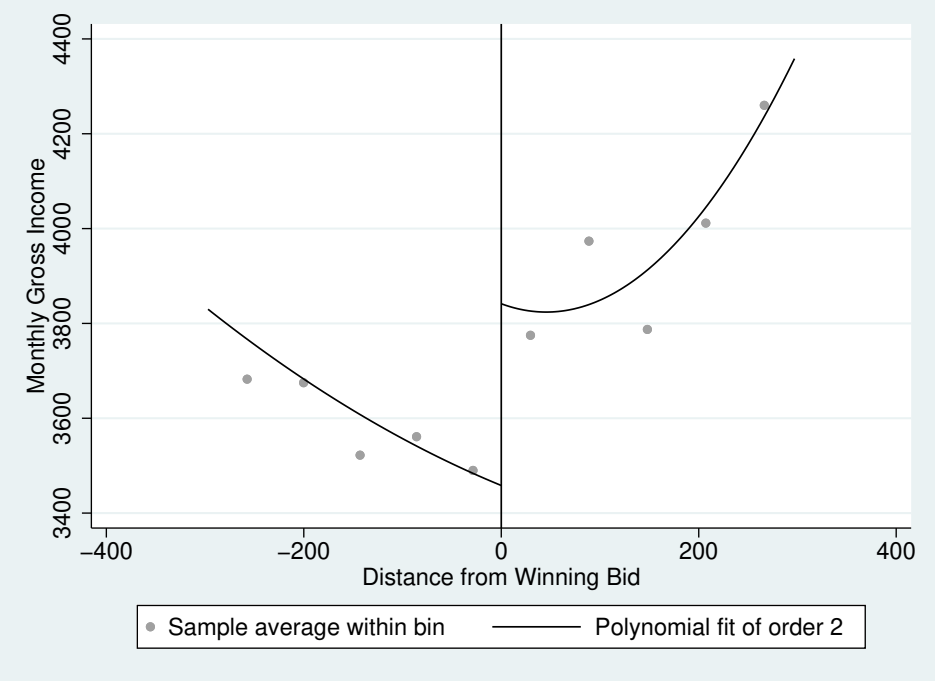

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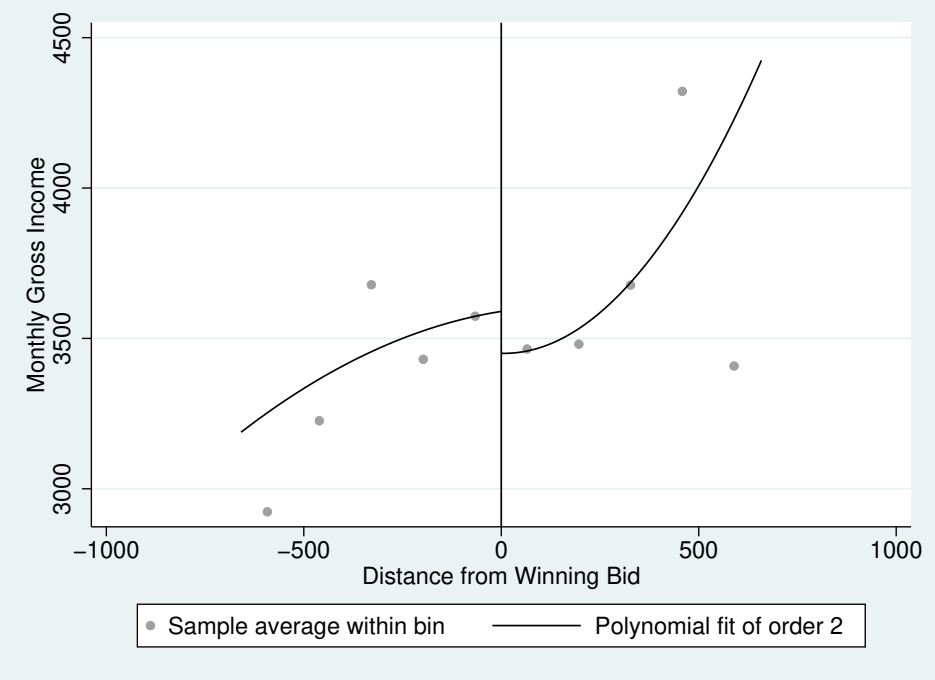
Figure 9: Null Returns to CS for Engineers



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5 Conclusion

In this paper, I study the returns to taking particular courses and developing specific human capital at the university level. National University of Singapore (NUS) provides a unique setting in which students bid to take courses each semester. I exploit a regression discontinuity design (RDD) to quantify the impact of taking specific courses. Specifically, close to the thresholds that determine a winning bid, individuals with very similar bids may be enrolled or turned away from taking the course. I find that learning a second language increases monthly gross income by about 300 USD. Taking statistics elective courses increases monthly gross income by about 650 USD. I also find evidence for positive income returns to Computer Science related electives, and Finance. I don't find significant returns for elective courses offered by general science or humanities departments.

Additional Figures

Figure 10: First Stage - Single Course

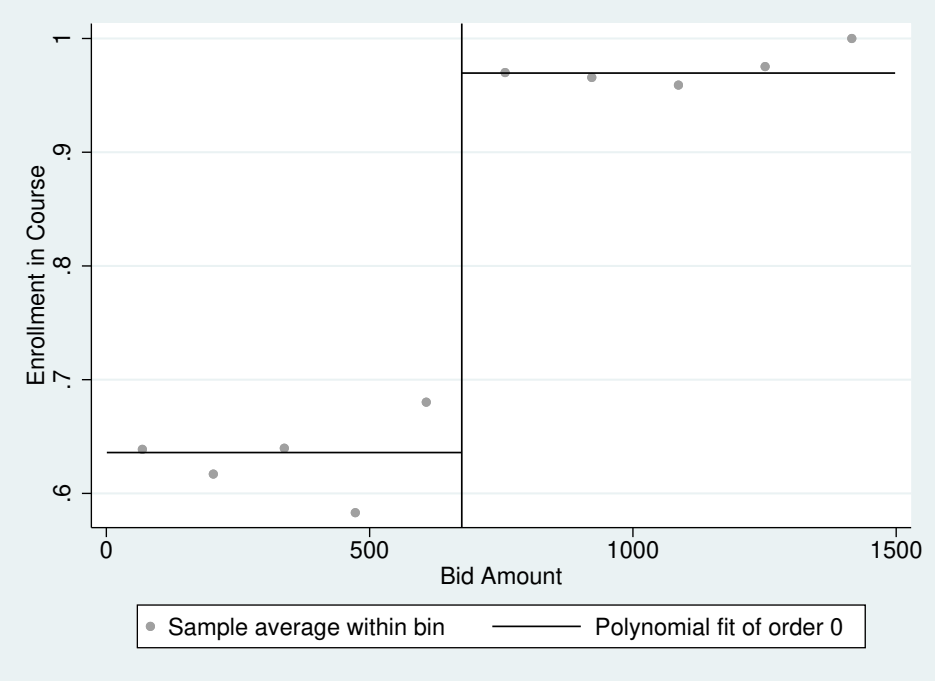

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Figure 11: Continuity of Predetermined Variables: Gender

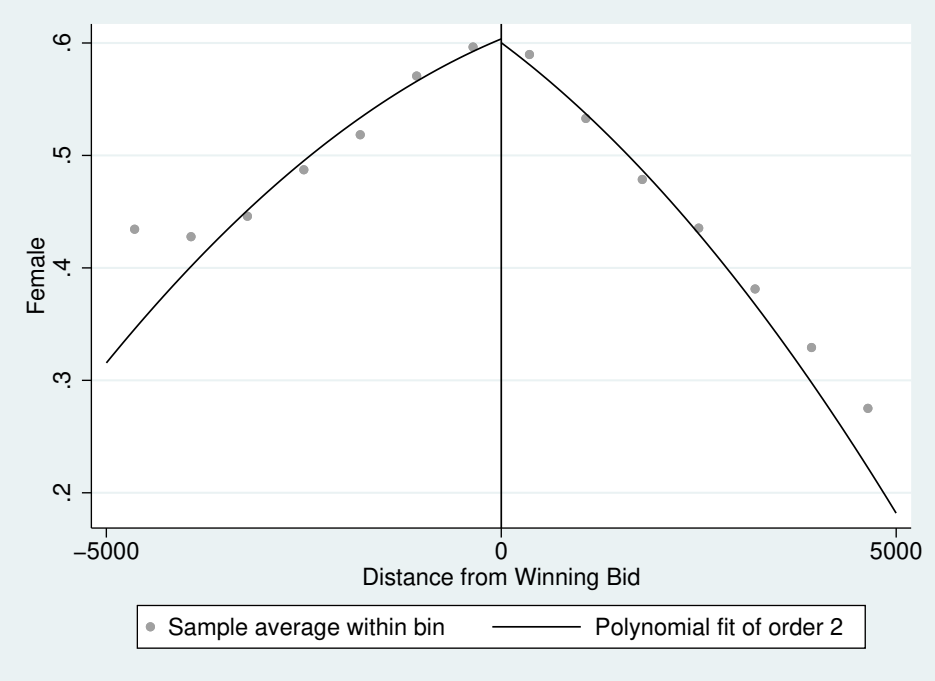

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Figure 12: First Stage - Statistics

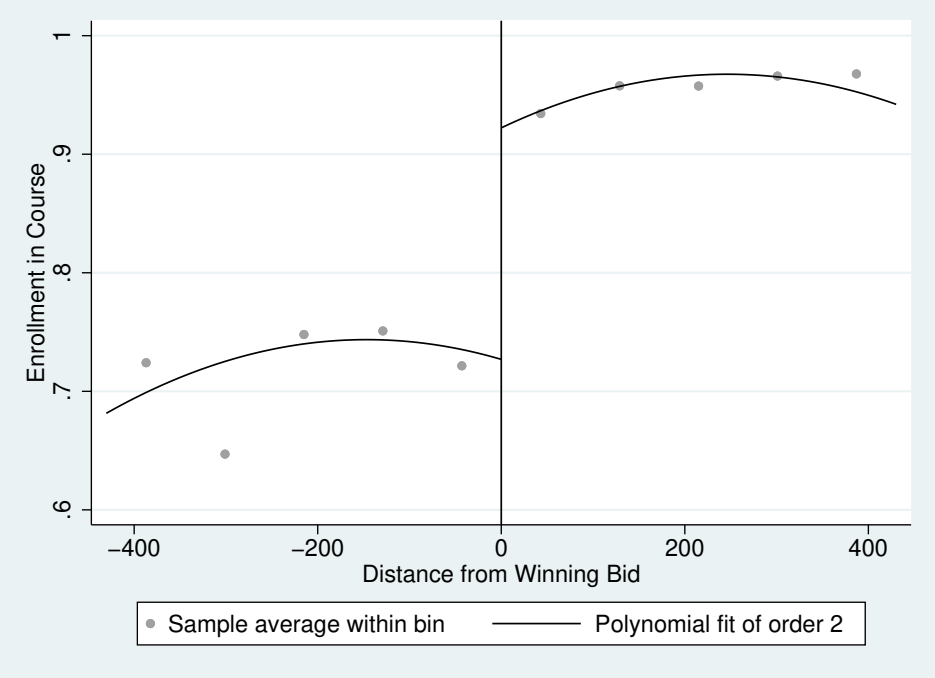

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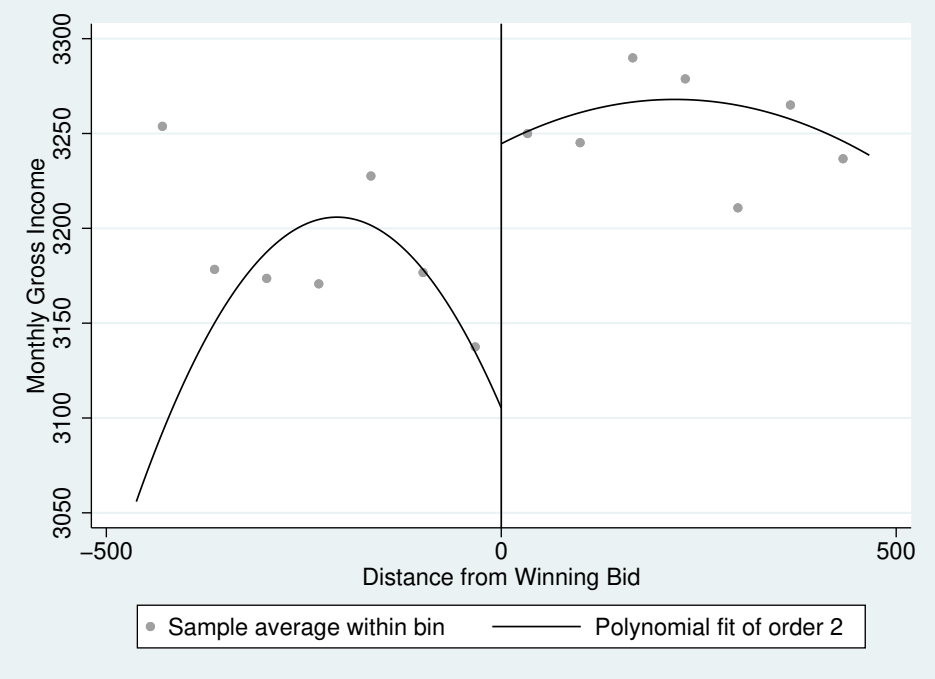
Figure 13: Returns to Statistics



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