# Freshmen Teachers and College Major Choice: Evidence from a Random Assignment in Chile

**Abstract**

We exploit the exogenous characteristic of random freshmen course assignment in a large Chilean university to identify the causal effect of teachers and their qualitative characteristics over students' major choice. Using administrative records, we establish what makes students from the "Commercial Engineering" career chose between an "Economics" major or a "Business" major. We find that first economic-course teachers may account for 15-22% of the probability of choosing Economics as a major. We also identify which characteristics of these teachers make students more prone to choosing this particular major. These results are robust to the inclusion of different covariates and specifications.

Keywords: Freshmen Teachers, College Major, Random Assignment

JEL Codes: A23, C93, I23, J24.

*I am grateful to the Centre for Teaching and Learning at the School of Economics and Business at the university referred to in this study for great support under Fondecyt Grant No. 11150794. Financial support was provided by CONICYT PCHA/MagisterNacional/2016 - 22160211.*

# INTRODUCTION

## *About major choice*

In recent years, several studies have focused on the subject of college major choice. Indeed, major choice is a well-studied subject in many dimensions because of its relevance in the configuration of our society's tertiary-educated citizens. This issue has been in the spotlight over the past decades, as it is a common phenomenon around the world to see, for instance, low female enrollment rates in Engineering and Economics majors (Bettinger and Long, 2005), higher enrollment rates in high-return majors for upper-class students (Macmillan, Tyler, and Vignoles, 2015), among other stylized facts.

The latter examples depict some well-addressed relations between college major choice and student characteristics. Nevertheless, other important determinants of college major choice lie on the other side of the classroom: teacher characteristics.

There are a lot of insights from other social sciences such as psychology or sociology that confirm the importance of teachers on students' major choice decisions (Chambliss and Takacs, 2014). That is, an important future-determining choice that one might consider as completely endogenous may still be highly conditioned by external factors such as role-model shocks induced by instructors (Canes and Rosen, 1995; Rask and Bailey, 2002; Zafar, 2013) or informational shocks that affect the future prospect of a major for each student (Wiswall and Zafar, 2015; Hastings, Neilson, and Zimmerman, 2015).

Notwithstanding, there is an important challenge for economists to quantify these external effects, as usually students choose their teachers according to unobserved characteristics and therefore endogenously determine these "external" shocks that affect their major choice. To address this issue, we exploit the exogenous characteristic of random freshmen course assignment in a large Chilean university to identify the causal effect of teachers and their qualitative characteristics over students' major choice.

In order to fully understand our methodology, some briefing on the underlying institutional setting is provided in the next subsection.

## *Institutional setting*

The Chilean higher education system possesses some particular features that converts it into an interesting case to study college major choices. First of all, the main mechanism to access tertiary education is through a nationally standardized set of tests called *Prueba de Selección Universitaria* (PSU). Once students obtain their test scores, they may choose among universities subscribed to this general system (there are some universities that don't qualify into this system) by ranking their programs in a nationally-centralized admission system. After this, each university fills each program's capacity with the higher-scoring students that opted for them. Students get enrolled only in the topmost program in which they got accepted. For a thorough description of the Chilean higher education admission system, see Bordon and Fu (2015).

The important part for this study is what comes next. In the School of Economics and Business of one of Chile's largest universities, when students get enrolled as freshmen, they get their initial courses assigned randomly, i.e. they can't choose their teachers until they start their second

semester. This ensures that first-semester teachers are completely exogenous for these freshmen, and so are the eventual shocks they might receive from them.

This School offers three programs: i) Commercial Engineering, ii) Engineering in Information and Management Control and iii) Accounting-Auditing. An important fact is that the former program mandates students in their second year to choose between two radically opposite majors: Economics or Business. It's because of this characteristic that we'll pose our attention on students enrolled in the Commercial Engineering program.

As a last part of this short institutional setting briefing, we'll also exploit a mandatory survey that students must fill each semester. In this survey there is a module oriented to teacher characteristics, in which students rate each professor they had in that corresponding semester. For more details on the questionnaire, see Table 4 in Appendix A.

The rest of the document is structured as follows: section 2 shortly reviews some of the existing literature, section 3 presents a simple model which, combined with the data presented in section 4, allows different specifications from section 5 to obtain the results from section 6. Finally, section 7 concludes.

## LITERATURE REVIEW

There is a broad (and somewhat controvertial) literature in educational economics concerning college major choices. For instance, Montmarquette, Cannings, and Mahseredjian (2002) use mixed multinomial logit and probit models to identify the effect of expected earnings on the probability that a student will choose a specific major among four choices of concentrations, while Arcidiacono (2004) and Arcidiacono, Hotz, and Kang (2012) develop structural models to explain college major choices based on the expected future stream of income that each one yields.

On the reduced-form side, Sacerdote (2001) and Sohn (2016) exploit different natural experiments to identify their effects on educational outcomes, among them, college major choice. Wiswall and Zafar (2015) explicitly focus on college major choice by implementing a randomized controlled trial with an informational treatment.

There's also a lot of interest in determining till what extent teachers influence students in different dimensions. Influence can be though many mechanisms, like gender-matching (Paredes, 2014), race-matching (Dee, 2004) or simply because of the teacher's quality (Carrell and West, 2010).

Notwithstanding, research focusing on the causal effects of teachers (and their characteristics) on college major choices is scarce. For a superb review of the existing literature, see Grove and Wu (2011). This shortage of literature is mainly because usually teachers are endogenously chosen at college and therefore this yields the typical absence of an appropriate counterfactual to identify the effect (Holland, 1986). Other important reason may be the lack of direct policy implications. We'll get back to this shortly.

Thus, there are a few randomized controlled trials, but no one has explored deeply into individual characteristics of teachers and how they affect college major choices. A contribution of this document is the use of a rich and extensive data set that, through a random assignment, allows for a causal identification (Rubin, 1974) of the effect of particular teacher characteristics on college major choices.

## THE MODEL

Despite basing our results on a random assignment, an underlying theoretical model is explicitly presented to account for the eventual assumptions being made when computing treatment effects (Keane, 2010).

Consider that student $i$ may choose between majoring in Business or in Economics. Denote the observed outcome $Y_i$ as 1 if she chooses Economics and 0 if not. Suppose that there is a tacit net utility of choosing Economics over Business for student $i$ and denote it as $U_i$. Thus, we have that

$$(1)\ Y_i = \begin{cases} 1 & iff \quad U_i > 0 \\ 0 & iff \quad U_i \leq 0 \end{cases},$$

i.e. student $i$ is fully rational and will choose a major if and only if it yields a higher net utility than the other.

Now we impose some structure on $U_i$, letting it be

$$(2)\ U_i = \beta_0 + \sum_{j \in J} \beta_j T_{ij} + \mathbf{XB} + \varepsilon_i,$$

where $T_{ij}$ is 1 if student $i$ was assigned to teacher $j$ in set $J$ and 0 if not, $\mathbf{X}$ is a set of observed characteristics and $\varepsilon_i$ is an unobserved error component. In this case, $\beta_j$ may be interpreted as the effect of a non-specific shock received by a student from teacher $j$, just as we commented before.

Suppose now that $\varepsilon_i \sim N(0, \sigma_t^2)$, where $t$ indexes years/cohorts. Then, substituting (2) in (1) we get

$$Y_i = \begin{cases} 1 & iff \quad \beta_0 + \sum_{j \in J} \beta_j T_{ij} + \mathbf{XB} + \varepsilon_i > 0 \\ 0 & iff \quad \beta_0 + \sum_{j \in J} \beta_j T_{ij} + \mathbf{XB} + \varepsilon_i \leq 0 \end{cases}.$$

But $\beta_0 + \sum_{j \in J} \beta_j T_{ij} + \mathbf{XB} + \varepsilon_i > 0 \Leftrightarrow \varepsilon_i > -\left( \beta_0 + \sum_{j \in J} \beta_j T_{ij} + \mathbf{XB} \right)$ and the odds of this event are equal to

$$\Pr\left( Y_i = 1 \middle| \{T_{ij}\}_{j \in J}, \mathbf{X} \right) = \mathbf{\Phi}\left[ \left( \beta_0 + \sum_{j \in J} \beta_j T_{ij} + \mathbf{XB} \right) \middle/ \sigma_t \right],$$

where $\mathbf{\Phi}$ is a cumulative standardized Gaussian distribution.

Therefore, we finally obtain a reduced-form probit model described by

$$Y_i = \beta_0 + \sum_{j \in J} \beta_j T_{ij} + \mathbf{XB} + \varepsilon_i.$$

## DATA

We use administrative data from a large Chilean university, particularly from its School of Economics and Business. We possess information from ten cohorts spanning from 2005 to 2014 on a biannual basis (whole available database).

The data is restricted only to freshmen enrolled in Commercial Engineering on their first semester whose teachers were randomly assigned. Their major choice is retrieved from the same administrative records.

For identification purposes, we'll be interested in the Introduction to Economics (ECON101) course. In this way, $T_{ij}$ will be 1 if student $i$ was assigned to teacher $j$ in the ECON101 course, so $J$ is restricted to the set of (thirteen) teachers that dictate ECON101 in the sample.

Additionally, we only consider teachers that have been at least 2 years with the course. This ensures a minimum amount of student observations per teacher and eliminates potential noise generated by "first-and-last-time" teachers (with no experience, where the course was not of their preference, etc.). Figure 1 shows the average probability of majoring in economics over all the considered ECON101 professors.

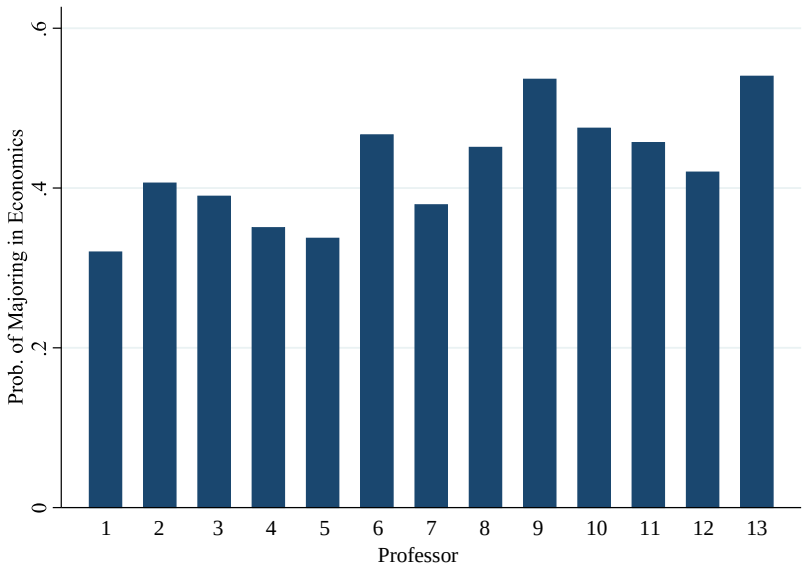


Figure 1: Percentage of Students Majoring in Economics by Professor

Finally, we count with several control variables such as the grade (scaled continuously from 1 to 7) of each student on the ECON101 course, the entrance score constructed as a weighted average their PSU scores, their preference ranking for the program, their school GPA, the week days on which the ECON101 course is dictated (1 if lectures are held Monday and Thursday and 2 if they're held Tuesday and Friday), a failure status dummy and a "Block" variable that indicates the time schedule in which lectures are held. This variable is equal to 1 if lectures are from 8:00 am to 9:30 am, 2 if they are from 9:40 am to 11:10 am, 3 from 11:20 am to 12:50 pm, 4 from 1:30 pm to 3:00 pm, 5 from 3:10 pm to 4:40 pm and 6 from 4:50 pm to 6:20 pm.

Summary statistics for all of these variables are presented in Table 1. Note how about 40% of the students choose Economics as their major, so we have enough variation in majors to identify effects. It's also important to note that this School has relatively high entrance scores, as the country's mean score in each test is standardized to 500 points with a standard deviation of 110 points, i.e. the School's mean is two standard deviations over the national average. School GPA's mean is over 90% of the full score and failure rates are relatively low for the ECON101 course (about 12%). Bivariate histograms are shown for the former two variables in Figure 2 for students majoring in Economics and in Figure 3 for Administration majors while individual densities are shown in Figure 4 and Figure 5 for each major.

Table 1: Summary Statistics

| | Obs. | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| Econ. Major | 1561 | .4144779 | (.4927895) | 0 | 1 |
| ECON101 Grade | 1829 | 4.793166 | (.9228158) | 1.2 | 7 |
| Entrance Score | 1827 | 723.9126 | (23.40134) | 679.1 | 830.2 |
| Preference | 1340 | 1.485821 | (.6619559) | 1 | 4 |
| School GPA | 1827 | 6.414926 | (.2583345) | 5.1 | 7 |
| Week Days | 1829 | 1.300164 | (.4584545) | 1 | 2 |
| Failed ECON101 | 1829 | .1246583 | (.3304214) | 0 | 1 |
| Prof. 2 | 1829 | .0437397 | (.2045714) | 0 | 1 |
| Prof. 3 | 1829 | .0732641 | (.2606407) | 0 | 1 |
| Prof. 4 | 1829 | .1388737 | (.3459093) | 0 | 1 |
| Prof. 5 | 1829 | .1098961 | (.3128458) | 0 | 1 |
| Prof. 6 | 1829 | .0464735 | (.2105658) | 0 | 1 |
| Prof. 7 | 1829 | .1394204 | (.3464795) | 0 | 1 |
| Prof. 8 | 1829 | .0656096 | (.2476662) | 0 | 1 |
| Prof. 9 | 1829 | .0415528 | (.1996194) | 0 | 1 |
| Prof. 10 | 1829 | .1306725 | (.337134) | 0 | 1 |
| Prof. 11 | 1829 | .1170038 | (.3215128) | 0 | 1 |
| Prof. 12 | 1829 | .0322581 | (.176733) | 0 | 1 |
| Prof. 13 | 1829 | .0311646 | (.1738098) | 0 | 1 |
| Block. 2 | 1829 | .2121378 | (.4089337) | 0 | 1 |
| Block. 3 | 1829 | .1618371 | (.368402) | 0 | 1 |
| Block. 4 | 1829 | .0896665 | (.2857815) | 0 | 1 |
| Block. 5 | 1829 | .0426463 | (.2021135) | 0 | 1 |
| Block. 6 | 1829 | .049754 | (.2174957) | 0 | 1 |
| Year 2006 | 1829 | .0978677 | (.2972169) | 0 | 1 |
| Year 2007 | 1829 | .0967742 | (.2957309) | 0 | 1 |
| Year 2008 | 1829 | .1109896 | (.3142052) | 0 | 1 |
| Year 2009 | 1829 | .0995079 | (.2994246) | 0 | 1 |
| Year 2010 | 1829 | .1328595 | (.3395156) | 0 | 1 |
| Year 2011 | 1829 | .0978677 | (.2972169) | 0 | 1 |
| Year 2012 | 1829 | .0448332 | (.2069943) | 0 | 1 |
| Year 2013 | 1829 | .1109896 | (.3142052) | 0 | 1 |
| Year 2014 | 1829 | .1388737 | (.3459093) | 0 | 1 |

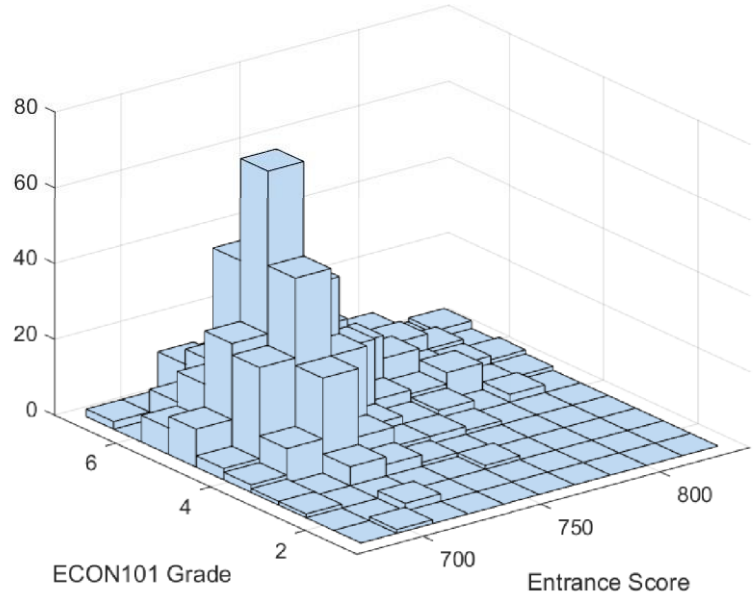


Figure 2: ECON101 Grade and Entrance Score for Economics Majors

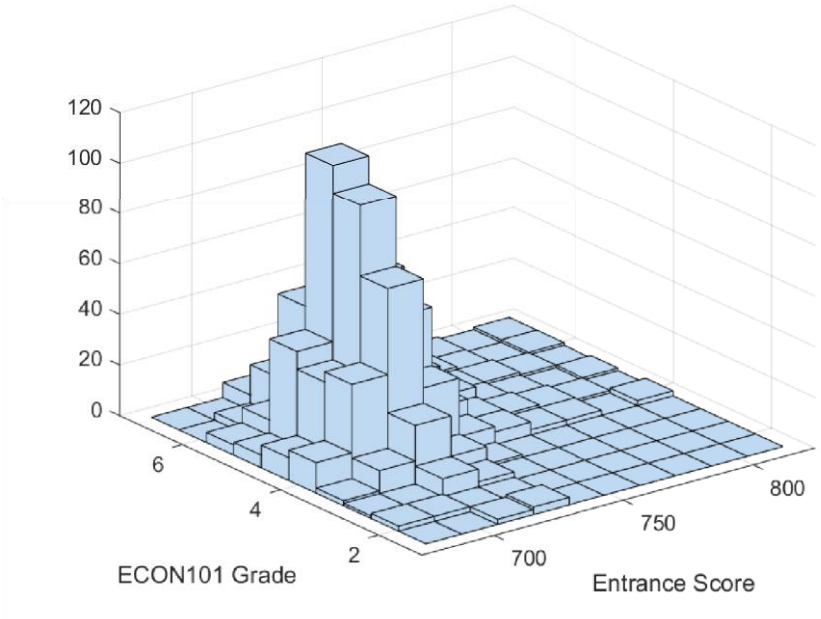


Figure 3: ECON101 Grade and Entrance Score for Administration Majors

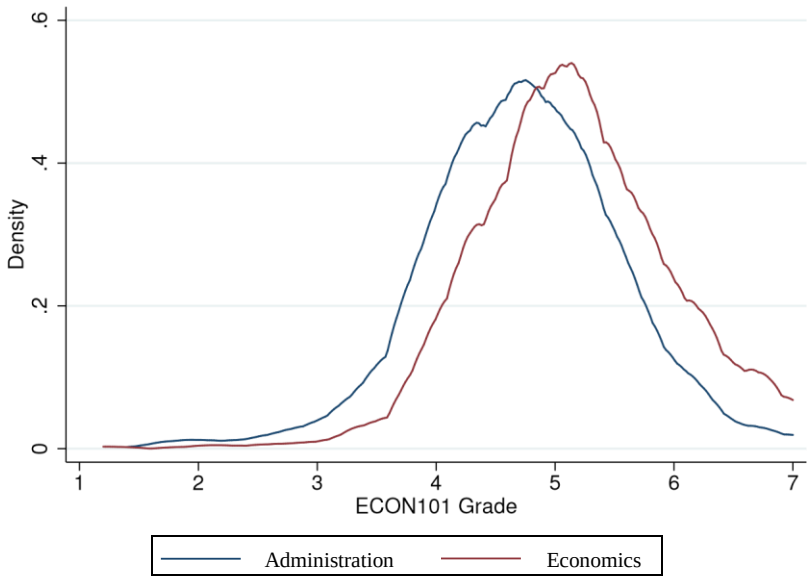


Figure 4: ECON101 Grades of Economics and Administration Majors

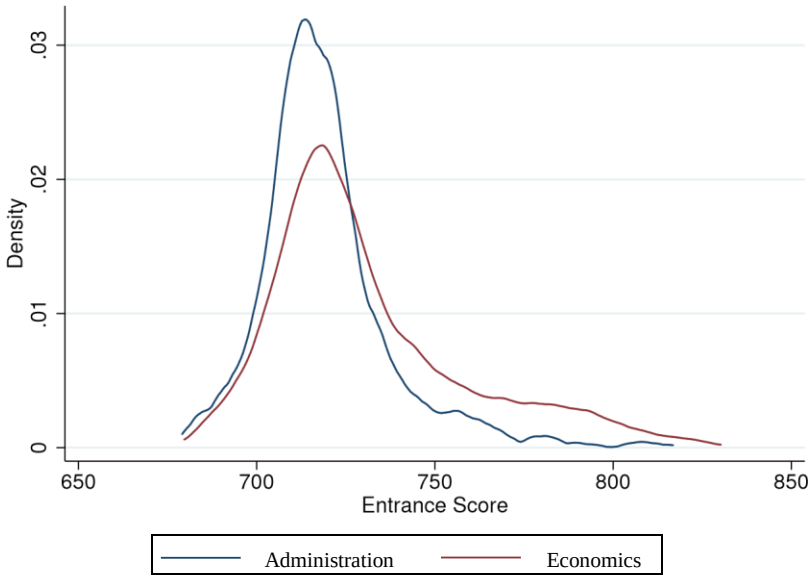


Figure 5: Entrance Scores of Economics and Administration Majors

A potential threat is given because the data set is very unbalanced, as some teachers have more than 13% of observations while others barely pass 3%. Years are more balanced, but we still have problems with year 2012. Other caveat is the fact that $\beta_j$ might not be identifying the effect of teacher $j$, but might include confounding effects such as teacher $j$'s TAs or the classroom assigned. In this sense, the effect may be interpreted as an all-inclusive effect, not only as the single impact of the teacher.

Having all of this clear, we may explain our main identification strategy.

## IDENTIFICATION STRATEGY

Course assignment is random, conditional on program. As our sample consists uniquely of students of the Commercial Engineering career, assignment is completely random for them.

We estimate the following pooled Probit model:

$$(3)\ Y_i = \beta_0 + \sum_{j \in J} \beta_j T_{ij} + \mathbf{XB} + \varepsilon_i ,$$

where $Y_i$ is 1 if student $i$ chooses economics as her major and 0 otherwise; $T_{ij}$ is 1 if she is assigned to professor $j$ in set $J$ and 0 otherwise; $\mathbf{X}$ is a set of student and course covariates and $\varepsilon_i$ is a well-behaved unobserved component.

In this case, the $\beta_j$ coefficients in (3) will account for the mean effect of teacher $j$ (and all the other eventual confounding effects we discussed before) on the odds of choosing Economics as a major.

Additional to this main specification, a second (and surely more interesting) set of estimations are held. The idea is to recover the characteristics of teachers that make students more prone to choosing an Economics major. In order to do this, we make use of administrative data containing all the student responses to the Teacher Evaluation Survey (TES) that proxy twelve different characteristics of all professors. Thus, one may estimate the effect of each of these characteristics with the reduced-form probit model described by

$$(4)\ Y_i = \beta_0 + \sum_{j \in J} T_{ij} \left( \sum_{k \in K} \beta_k Q_{ijk} \right) + \mathbf{XB} + \varepsilon_i ,$$

where $Q_{ijk}$ denotes the score (ranging from 1 to 7) for teacher $j$ in characteristic $k \in K$ and where teacher-specific fixed components are included.

To account for the endogeneity of $Q_{ijk}$, it is replaced by $Q_{tjk}$, i.e. the average score of characteristic $k$ for professor $j$ in cohort $t$ (not provided by student $i$, but by her classmates). Therefore, this aggregate measure of each characteristic is an exogenous covariate that may impact student $i$'s major.

## RESULTS

The results for the estimation of (3) with different controls are presented in Table 2. As one can easily see, significant coefficients are relatively stable under different specifications. Thus, there are four teachers that actually influence relevantly in students' major choice, evidencing that this decision may actually be exogenously conditioned. Moreover, there are some teachers that can even increment in over 20% the probability of choosing an Economics major, i.e. they can even neutralize the effect of failing ECON101!

Table 2: Probit Estimates (Marginal Effects)

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | Econ. Major | Econ. Major | Econ. Major | Econ. Major |
| Prof. 2 (d) | 0.0912 | 0.0252 | 0.0188 | 0.0191 |
| | (0.0897) | (0.0815) | (0.0751) | (0.0749) |
| Prof. 3 (d) | 0.0742 | 0.0634 | 0.0581 | 0.0583 |
| | (0.120) | (0.154) | (0.149) | (0.148) |
| Prof. 4 (d) | 0.0328 | 0.0565 | 0.0836 | 0.0841 |
| | (0.0860) | (0.105) | (0.0999) | (0.1000) |
| Prof. 5 (d) | 0.0186 | 0.0351 | 0.0619 | 0.0623 |
| | (0.0813) | (0.101) | (0.0959) | (0.0955) |
| Prof. 6 (d) | 0.152 | 0.129 | 0.132 | 0.132 |
| | (0.136) | (0.148) | (0.140) | (0.140) |
| Prof. 7 (d) | 0.0629 | 0.0519 | 0.0853 | 0.0856 |
| | (0.0925) | (0.101) | (0.0931) | (0.0926) |
| Prof. 8 (d) | 0.136 | 0.123 | 0.124 | 0.123 |
| | (0.0874) | (0.112) | (0.107) | (0.105) |
| Prof. 9 (d) | 0.220** | 0.214** | 0.214** | 0.215** |
| | (0.0994) | (0.107) | (0.101) | (0.101) |
| Prof. 10 (d) | 0.160* | 0.153* | 0.154* | 0.154* |
| | (0.0887) | (0.0931) | (0.0879) | (0.0884) |
| Prof. 11 (d) | 0.142** | 0.161* | 0.168** | 0.168** |
| | (0.0716) | (0.0875) | (0.0819) | (0.0824) |
| Prof. 12 (d) | 0.105 | 0.132 | 0.120 | 0.120 |
| | (0.0863) | (0.113) | (0.109) | (0.108) |
| Prof. 13 (d) | 0.223* | 0.228* | 0.215 | 0.215 |
| | (0.123) | (0.126) | (0.131) | (0.131) |
| Failed ECON101 (d) | | | -0.236*** | -0.236*** |
| | | | (0.0433) | (0.0439) |
| School GPA | | | | 0.00258 |
| | | | | (0.0374) |
| Block Controls | NO | YES | YES | YES |
| Observations | 1561 | 1561 | 1561 | 1559 |

Marginal effects; Standard errors in parentheses

(d) for discrete change of dummy variable from 0 to 1

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 3: Effect of Teacher Characteristics on Major

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | Econ. Major | Econ. Major | Econ. Major | Econ. Major |
| Shows Confidence | -0.0366 | -0.0189 | -0.00832 | -0.00224 |
| | (0.128) | (0.127) | (0.125) | (0.127) |
| Prepares Classes | 0.0202 | 0.00787 | 0.0353 | 0.0228 |
| | (0.0736) | (0.0829) | (0.0845) | (0.0876) |
| Exposes Clearly | -0.0327 | -0.0355 | -0.0468 | -0.0479 |
| | (0.140) | (0.158) | (0.160) | (0.160) |
| Solves Doubts | -0.0963 | -0.0802 | -0.0926 | -0.0925 |
| | (0.185) | (0.195) | (0.194) | (0.194) |
| Promotes Discussion | -0.122 | -0.110 | -0.0867 | -0.0890 |
| | (0.112) | (0.107) | (0.106) | (0.107) |
| Allows Sharing Ideas | 0.305** | 0.264* | 0.276** | 0.276** |
| | (0.146) | (0.136) | (0.133) | (0.136) |
| Stimulates Interest | 0.199*** | 0.213** | 0.210** | 0.211** |
| | (0.0769) | (0.0972) | (0.0966) | (0.0966) |
| Evaluates Fairly | 0.142*** | 0.149** | 0.125** | 0.132** |
| | (0.0551) | (0.0704) | (0.0593) | (0.0593) |
| Shows-up Punctually | -0.0434 | -0.0312 | -0.0315 | -0.0256 |
| | (0.0629) | (0.0685) | (0.0695) | (0.0694) |
| Meets Deadlines | 0.00697 | -0.00686 | -0.0103 | -0.0123 |
| | (0.0333) | (0.0446) | (0.0483) | (0.0476) |
| Treats Respectfully | -0.280*** | -0.293*** | -0.307*** | -0.308*** |
| | (0.104) | (0.113) | (0.107) | (0.105) |
| Is Available | -0.00122 | 0.00390 | -0.00170 | -0.00310 |
| | (0.0635) | (0.0711) | (0.0713) | (0.0717) |
| Failed ECON101 (d) | | | -0.235*** | -0.235*** |
| | | | (0.0373) | (0.0376) |
| School GPA | | | | -0.00538 |
| | | | | (0.0430) |
| Block Controls | NO | YES | YES | YES |
| Observations | 1540 | 1540 | 1540 | 1539 |

Marginal effects; Standard errors in parentheses

(d) for discrete change of dummy variable from 0 to 1

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

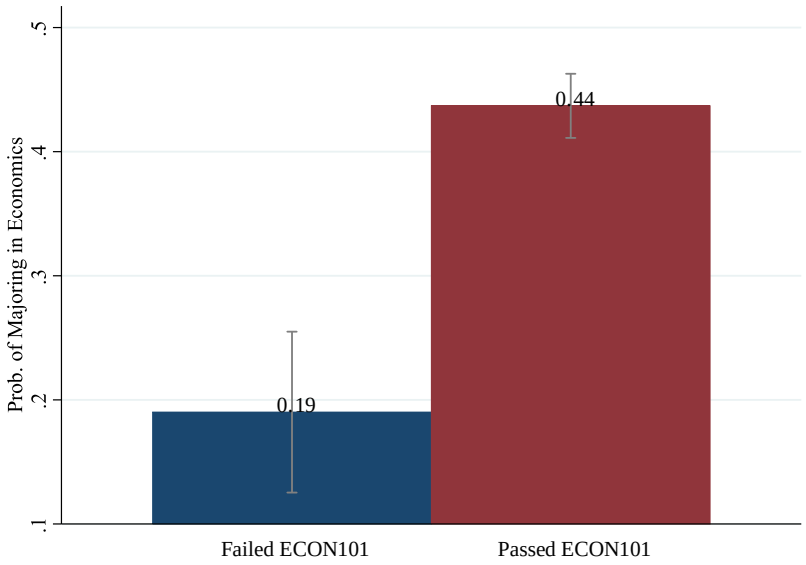


Figure 6: Prob. of Majoring in Economics by ECON101 Situation

When digging into what characteristics make students more prone to choosing the Economics major (Table 4), there are four winners. The first and most important characteristic is related to the extent up till which teachers allow questions and expressing ideas (Characteristic 6 from Appendix A). Indeed, one might expect economists as "social scientists" to be more oriented towards expressing their opinion about any social matter.

A second characteristic is precisely how stimulating is the teacher when advancing through the syllabus. This surely proxies how much interest for economics will be rooted in each student. A third, but less relevant characteristic indicates the perception of fairness in evaluations. Students that feel they were evaluated unfairly are mostly the ones with worst grades. Thus, this may seriously correlate with ECON101 grades and therefore major choice.

As a final characteristic, we have how respectful is a teacher with her students. In this case, the effect is negative, i.e. if teachers are respectful, students are less prone to choosing Economics. One might think that respectfulness and closeness with students may be negatively correlated, and thus, "disrespectful" ECON101 teachers may actually just be more friendly to students, making them have a better prospect of Economics as a major.

## CONCLUDING REMARKS

Contrary to what one may think, important decisions such as choosing a college major are not completely endogenously taken. Indeed, there is a significant and economically important effect of freshmen teachers over college major choice. The conditioning estimated effect of teachers on the chances their students opt for the Economics major spans from about 15% to almost 22%. This is robust to different specifications.

There are also certain characteristics that exogenously bend students towards choosing Economics as a major. These make intuitive sense and may be also very relevant when making this decision.

As in most "experimental designs" such as this one, there is a clear lack of external validity. Indeed, there is no way to ensure such results may be replicated in other context, not even with the same program and in the same country (as we commented earlier, this is a very selective university with a very particular context.). Thus, results must be handled with care and policy implications must not blindly follow them, but use them as a case study with high internal validity.

Finally, as a future research agenda we'd like to propose considering other dimensions in which teachers may causally impact students and their future career development. These kinds of random assignments are a great opportunity to explore and answer important questions on how higher-education students are formed and how does this formation impact the configuration of our future tertiary-educated society.

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## APPENDIX

### *A. Questionnaire of TES*

Table 4: Teacher Evaluation Survey

| Q | Characteristic (in Spanish, just as in actual TES) |
|---|---|
| 01. | Demuestra seguridad y dominio sobre las materias |
| 02. | Prepara las clases |
| 03. | Es claro para exponer las materias |
| 04. | Resuelve dudas y problemas de los alumnos |
| 05. | Incentiva la discusión y participación |
| 06. | Permite hacer preguntas y expresar ideas |
| 07. | Estimula el interés por las materias |
| 08. | Hace evaluaciones justas y razonables |
| 09. | Asiste puntualmente a clases |
| 10. | Cumple plazos y normas establecidas |
| 11. | Trata a sus alumnos con respeto |
| 12. | Está disponible para sus alumnos |