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Did free tuition change the choices of students applying for university admission?

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Abstract
How does a policy of free tuition affect student applications to universities? This article assesses how free tuition influences applications in terms of the selectivity of the university, length of the degree program, cost of the program, and application to a program in the STEM field. The study based on a quasi-experimental design was carried out in Chile using OLS, regression adjustment and matching analysis, and governmental data. Participants in the study were 384,830 applicants from three cohorts of high school graduates who applied to 30 selective universities. Two groups of applicants were compared: those who applied in 2015, before the introduction of free tuition; and those who applied in 2016 and 2017, when free tuition was introduced. The comparison was made considering the group with the lowest family income. Except for cost, the results show that the offer of free tuition had a small impact on the choices of applicants. With free tuition, a few more students applied to higher cost programs. The response may be explained in part by the fact that free education replaced the financing mechanism based on scholarships and loans, which covered a large part of the costs of the degree programs.

Keywords Free tuition · Program cost · Program length · Selectivity · Applicant choices

Introduction

Recent studies have focused on assessing the impact of free tuition (Nguyen, 2019; Rivera, 2019; Facchini et al., 2021) . Private finance, once justified by classifying education as an investment with high private yields, has failed to reduce high levels of social and economic inequality. Extensive public financial aid including free tuition is now seen as a right and a way to at last equalize opportunities across social strata (de Gayardon, 2019) . Research assessing changes in access, retention, and graduation from higher education has reported positive results.

Chile has experienced a massive growth in enrollment. The expansion of enrollment was such that the government declared higher education a basic right. In order to eliminate family finance as a barrier to access and retention in higher education, the government instituted a policy of free tuition in 2016. The policy began by eliminating tuition fees

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only for low-income students, but with the intention of eventually providing free education for all (Subsecretaría de Educación Superior, 2021b). Prior to this action, the government had provided two forms of tuition assistance: tuition scholarships offered to low-income students and guarantees for commercial bank loans for all students independent of income.

The new policy initially offered free tuition only to students from the bottom half of the income distribution. Two years later, it was raised to cover the lower 60th percentile. The free tuition covered the costs through graduation in the program to which students were originally admitted. The amounts of the grant were set by the Ministry of Education, which transferred funds to the participating universities. All public universities were included. Only private universities that had received 4 or more years of accreditation by the National Accreditation Commission could participate (Espinoza & González, 2016; Flores et al., 2020).

Higher education in Chile is offered in two subsystems, university and technical-professional. At present, there are 60 universities: about half participate in a uniform admission system (SUA); others admit students applying their own criteria. The SUA members include public universities, "traditional" private universities established prior to 1980, and new private universities established after 1980.

There are two ways to be admitted to a university in Chile. The easiest way is by applying directly to individual private universities founded after 1981. These universities, generally of lower prestige, essentially have open admission. The second way is to apply through SUA, which processes applications for all public and private universities cooperating in the system. In 2020, there were 96,052 students enrolled through SUA and 69,402 enrolled in the newer private universities (Subsecretaría de Educación Superior, 2021a).

Students who apply through SUA submit grades awarded during their 4 years of secondary school. The variable NEM is based on the GPA of students in the secondary school. Secondary grade point averages are weighted to reduce the effect of school differences in grading curves. This adjustment provides a variable called rank. The admission procedures also include taking the national University Selection Test (PSU), modeled after the American SAT. The PSU includes a battery of tests for various subjects (DEMRE, 2016). The two mandatory tests on the PSU are language and mathematics, scored to yield average scores of 500 with a standard deviation of 110. Only students scoring at 450 and above on these two continue in the selection process. About 44% of those taking the PSU are excluded at this point, either because they did not meet the minimum score requirement or because they voluntarily drop out (DEMRE, 2016).

The applicants may indicate their preferences for university and field of study (degree program). The application form lists the programs offered by each university, together with the minimum score for admission to each program, and the number of vacancies to be filled. Applicants can indicate in rank order up to 10 combinations of university-program preferences.

In 2016, there were 138,951 (continuing and newly admitted) students enrolled in SUA universities who benefitted from the free tuition policy. In 2018, the policy was expanded to include students in the lower 60% of the income distribution, raising coverage to 35% (399,165) of the SUA university student population (Subsecretaría de Educación Superior, 2021b). By 2019, the cost of free tuition amounted to 41.4% of public expenditure allocated to higher education (Contraloría General de la República, 2019). Free tuition, justified in terms of equity, is clearly a costly initiative.

For that reason, it is important to assess whether free tuition affects the enrollment of low-income students, for whom financial resources have in the past inhibited enrollment in higher education. Research to date has focused on rate of enrollment (Arzola, 2021),

financing at the institutional and system level, and the socioeconomic profile of students (Salas & Jara, 2019). The offer of free tuition may increase enrollments in the longer (more costly) programs in the STEM area. Some studies have looked at effects on outcomes (Arzola, 2021; Espinoza et al., 2021; Flores et al., 2020).

Little is known about student decisions at the moment of application for admission. What has been the impact of the offer of free tuition students' decision-making when applying for admission? Little is known about whether outcomes have lived up to expectations. As a result, the extent to which free tuition has affected the ambitions of those seeking admission to higher education is not yet clear.

Given the above, the research question guiding this research is as follows: Did the introduction of free tuition affect the choices students make when apply for admission? One might expect that although once impossible, free tuition would now make enrollment in selective universities and longer degree programs a reasonable choice (Breen & Goldthorpe, 1997). On the other hand, students from low-income families with no higher education experience may lack information necessary to make rational choices (Liu, 2019).

The study reported in this article evaluated the impact of free tuition on the initial cohort of applicants to selective universities. The study examined the preferences of applicants based on four indicators: university selectivity, length of program, cost of program, and inclusion in the STEM area. The analysis assesses the association of various background characteristics with preferences.

A comparison of theoretical perspectives on factors affecting choices about higher education

Most research on student preferences in higher education has relied on one of two theories of decision-making. In both theories, the effects of aspirations on choices of program and university are conditioned by contextual factors and expected outcomes (returns or benefits) (Buchman & Dalton, 2002; DeBacker & Routon, 2017). The earliest theory, developed by economists, was based on empirical studies that show that completion of higher education benefitted both individual students (in the form of higher earnings and social status) and employers (as more highly educated workers are more productive) (Becker, 1962; Psacharopoulos & Patrinos, 2018). Graduates seeking to maximize measurable economic outcomes use information about education as predictors of future income and productivity.

This process of deciding on educational alternatives is explained by rational action theory (RAT) (Breen & Goldthorpe, 1997; Goldthorpe, 1996). The explanation is based on two assumptions: that the primary objective of students and families in seeking higher education is maximization of income and social status (Heckman, 2000); and that most students and families possess the information necessary to make rational choices.

An alternative theory has argued that both the aspirations and the information that individuals have are conditioned by the particular social, economic, and cultural context in which they live (Bourdieu & Passeron, 1977; Liu, 2019; Patfield et al., 2021). In highly differentiated societies, those living in different contexts can develop different aspirations for their future and acquire different types of information about how best to achieve them. Most societies are best described as multicultural, shaped by the distinct political, economic, racial or ethnic, linguistic, religious, and geographic contexts in which people live (Chang et al., 2019). In addition, within each sub-culture, the roles

assigned to women and men vary in terms of type of motivation (Mullen, 2014; Ding et al., 2021) and level of educational aspiration (Davies & Ercolani, 2021).

In most sub-cultures, members learn from early childhood the norms and values (aspirations) dominant in that sub-culture. Mothers typically spend more time with their children and it is their characteristics (e.g., level of education) that most influence a child's aspirations. The family, and then the community and schools, shapes the knowledge and skills a child can use to operate effectively in their local context (Ahearn, 2021; Scanlon et al., 2019). This cultural capital absorbed over time forms a "habitus" which enables the individual to formulate objectives and act effectively in their pursuit.

Most of the habitus is "second nature" to a person, who decides without explicit conscious awareness of the source of the aspirations that shape his decisions, nor of the source of his knowledge. In a given sub-culture, young people may be interested in academic learning or not, in high-income employment or not. Their choice of university or degree program may be motivated by economic aspirations or by other kinds of outcomes consistent with non-economic values. Students' decisions may be informationally appropriate in a familiar context but inappropriate in others. Their decisions are made "rationally" but the information on which they are based may have a limited validity.

From this perspective, the rational choice theory may be a special case, pertaining to individuals operating only in contexts familiar to them. Studies in the developed countries support the rational choice hypothesis. In the developing countries marked by high levels of social stratification, however, individuals aspiring to move into a different strata may lack the cultural capital necessary to make effective decisions in the new context (Espinoza et al., 2021). In a comprehensive review of research comparing the two perspectives, Hayes concludes that:

> Bourdieu's dispositional theory of practice is a useful sociological framework with which to analyze and explain the types of "irrational" economic behavior observed by behavioral economists. (Hayes, 2020, p. 29)

Decisions made by different socioeconomic groups may pursue different objectives, but can be equally rational (Ortiz-Gervasi, 2020). The two perspectives, cultural capital and rational decision-making, can be combined to offer a more complete explanation of students' university application decisions. For example, Davies et al., (2014) used this approach to study choices of higher education in the UK. They found positive associations between cultural capital, parents' education, and students' expectations of salary after graduation. DiMaggio (1982) showed how this approach explained the relationship of gender to the impact of cultural capital. Glaesser and Cooper (2014) compared evidence for cost–benefit reasoning among students in England and Germany. They concluded that while economic reasoning comes into play, the students' social origins (habitus) defined the aspirations that were sought.

Some studies find fewer striking results. Noble and Davies (2009) concluded that when secondary academic performance (grade point average) was controlled, cultural capital had no relationship with decisions of what to study in the university or where. Wohn et al., (2013) studied the effect of the spread of social networks via information technologies and concluded that one effect was homogenization of information, nullifying the importance of cultural capital as a determinant of students' aspirations and decisions with respect to university access.

The effect of decisions on educational and employment inequality

Three mechanisms explain how these decisions can contribute to educational and employment outcomes linked to individual characteristics. First, all individuals, independent of their social origin, seek to avoid downward social mobility (Keller & Zavalloni, 1964). The most advantaged groups are motivated to pursue the most prestigious options to maintain or elevate their position in the social structure. Less advantaged groups try to avoid downward mobility by choosing easier academic paths with a higher probability of completion.

Second, the estimations by students and their families of their probability of success in each program and university depend on their prior educational experience. As the more advantaged students grow up in more educated families and attend better schools, they are more likely to demonstrate higher academic performance (for example, on achievement tests) (Boudon, 1974). Higher levels of performance encourage them to have expectations of success and therefore to choose more demanding programs.

The third mechanism is the costs associated with the choices of university and program. More advantaged families can more easily absorb the cost of educating their children and, therefore, choose options matching or improving their socioeconomic status (Callender & Melis, 2022).

Free tuition in Chilean higher education and elsewhere

There are various ways to implement free tuition policies, but all respond to the logic of education as a right or on the need to reduce inequalities between social strata (de Gayardon, 2019) . Most discussion has centered on graduation and desertion rates (Adrogué & García, 2018; de Gayardón, 2017), student academic performance (Bhayani, 2021), and the academic quality of the process (Psacharopoulos and Papakonstantinou, 2005; Carvalho, 2010).

With respect to Chile, some research has been done on how free tuition affects students' academic performance (Flores et al., 2020), as well as how it affects access (Arzola, 2021). In terms of equity, free tuition is not effective since it has not led to an increase in the proportion of lower income students entering higher education (Arzola, 2021). A study by Espinoza et al. (2021) also found no significant increase in the enrollment of first-generation students after the introduction of free tuition. Both studies compared the proportion of enrolled low-income students before and after introduction of tuition gratuity.

With respect to free tuition's effect on equality of access, research has produced contradictory results. Some authors (Post, 2011; de Gayardón, 2017, 2019; Samuels, 2017) conclude that free tuition does not necessarily result in increased access, arguing that access was already high prior to its implementation. On the other hand, Rivera (2019) looking at Ecuador found that free tuition did permit enrollment of certain ethnic groups, women, and the poorest students, who previously were excluded. In response, de Gayardon (2019) maintains that not enough analysis has been done to support a definitive conclusion about free tuition's effects.

Aspiration and choice of program and university

Consistent with evidence from international research, in Chile, some studies have found that aspirations are linked to the family and educational context (Castillo &

Cabezas, 2010; González, 2018). There has been a steady increase in the proportion of women applying to and gaining access to higher education. Women continue, however, to prefer fields of study that result in occupations with lower levels of earning (Bordón et al., 2020).

The proportion of lower income students admitted to university has increased slightly. Researchers have shown that scores on the cognitive ability tests used to admit students are significantly correlated with mother's education and family income, in part because of differences in the quality of instruction in secondary schools (Catalán et al., 2022; Santelices et al., 2018).

Various studies have reached the conclusion that women are more inclined to go on to university than are men and to choose more selective universities (Sikora & Pokropek, 2011). In Chile, however, González, (2018) found no significant difference in the aspiration rate of men and women.

Overall, in the developed countries, the male–female gap is not wide; gender has little effect on decisions with respect to university application (OECD, 2021; UNESCO, 2021). A similar situation is found in countries with medium levels of development (OECD, 2016). There are, however, significant differences in choice of programs and at the post-graduate level (Guerrero & Rojas, 2019; Bordón et al., 2020).

Family financial status and preference of field of study

Fukushi (2010) emphasizes that in Chile the desire to attend university cuts across social and cultural strata. This desire is based on a belief in "credentialism" (González, 2018) , which defines the university diploma as an engine for social mobility. Prior to free tuition, university enrollments in Chile had expanded enormously, but had not yet generated an appreciable increase in the proportion of low-income students admitted to highly selective degree programs and earning high salaries after graduation. One possible explanation is that while more low-income students were being educated and employed, even more upper income students were entering the more selective programs and then higher paid and higher status occupations.

The failure of enrollment expansion to change employment outcomes was called effectively maintained inequality (EMI) by Lucas, 2001; Lucas & Byrne, 2017). They posited that advantaged groups always look for ways to differentiate themselves. As university degrees become more common, the more advantaged shift to diplomas from more selective and expensive universities, in longer programs leading to more prestigious professions. The study was designed to assess whether expanded enrollment of lower income students was accompanied by a shift in the enrollment practices of upper income students.

Methodology

Data

The study described below was quantitative, using a quasi-experimental design (Cohen et al., 2018). Data were provided by the Department of Evaluation, Measurement and Educational Registration (DEMRE) which processes university admission applications. The data include choice of universities, programs, socioeconomic background, and secondary school grades for 2015, 2016, and 2017.

As noted above, the year 2015 was immediately prior to the introduction of free tuition; applicants from this year were the control group for this study. The "treatment" group was students who applied in 2016 and 2017. The comparison of these years minimizes differences in the socioeconomic profiles of the two groups and permits an appreciation of the immediate effect of free tuition. A comparison of results in 2017 with those of 2016 permits an estimation of the persistence of effects of free tuition.

The sample frame included students who in 2015, 2016, or 2017 applied to one or more undergraduate programs in the 30 universities that in 2016 offered free tuition to qualifying students. The same universities existing in 2015 were considered as part of the 2016 and 2017 sample. The total number of applicants for the 3 years was 384,830 students. Some of the admission applications did not include complete information; these cases were ignored in the later analyses. Applicants could indicate up to 10 different choices of programs. The total number of recorded choices was 1,849,572.

Assumptions with respect to impact

The assumptions with regard to impact describe how variables will produce a given effect. They describe the casual logic of how a given policy achieves its desired objective. That is, they explain the sequence of events that should lead to the results (Gertler et al., 2016).

It is unusual in Chile for public initiatives to be explained in advance in terms of expected results. Often not even the expected result is explicitly defined. For that reason, evaluations of policies have to reconstruct their presumed purposes. Free tuition is no exception. This study, therefore, infers the expected results of the free tuition policy based on the text of official documents (Subsecretaría de Educación Superior, 2021b).

Free tuition could have, in addition to other objectives, that of meeting students' desire to attend the university. When the cost of attendance university is high, socioeconomically vulnerable students, even if they met university and programs' minimal requirements, are more likely to apply to the least expensive and least selective institutions and to programs of shorter duration and perceived lower difficulty. Given access to loans, families prefer to not risk the possibility of having to repay the loans after failure. They would, for example, be unlikely to apply to STEM programs as they are known to have high failure and dropout rates.

The introduction of free tuition was expected to change this perspective. It was hoped that it would not result in an EMI process. A rational choice is one based on an evaluation of costs and benefits, by estimating the rate of return to meeting all university requirements. With the assurance that university studies would not result in family debt or debt repayment, the fear of risk would be diminished leading to a greater disposition to apply for admission to institutions and programs that are more selective, longer duration and cost, and in the STEM field. If this were correct, then it is suggested that the expected results would be reflected in four dimensions: selectivity, costs, length, and STEM. The largest returns would be associated with programs in the most selective universities that are longer in duration and most expensive and in the STEM area (Meller & Lara, 2010).

The challenge in an impact evaluation is the construction of a convincing counterfactual. An intervention occurs in time t, when the level of the variable of interest is Yt. After the intervention, the important result is Y^{I}_{t+1}, which could have been Y^{0}_{t+1} if there had been no intervention. This is the counterfactual of the value of Y. The evaluation of the impact can be written as:

$$Impact = Y^1_{t+1} - Y^0_{t+1}$$

where Y^l is the result of interest such as the level of selectivity or the length of the program to which a student has applied. The $t+1$ refers to the time after the intervention in which one waits to see if the effect of the intervention is evident. The Y^0 indicates the same step but without the intervention (White & Raitzer, 2017). As it is not possible for the same situations to be true for the same situation, this variation serves as the best approximation as to the effect of the intervention.

In this case, the treatment group, those who were exposed to the intervention (introduction of free tuition), were the students in the first five deciles of the income distribution who applied to the 30 SUA universities in 2016 or in 2017, years in which free tuition was in effect. The control group was those students, also in the lowest five income deciles who applied to the same set of universities, before the initiation of free tuition. The identification strategy is therefore based on a before-after comparison of adjacent cohorts of students, using covariates in a linear regression model to control for compositional effects.

All 10 choices of each student of universities and programs were taken into consideration in the analysis. Based on prior research, it can be asserted that preferences are well represented by the four variables: university selectivity, program cost, program duration, and STEM programs.

The general model for estimating these effects is as follows:

$$Preference\ (length,\ selectivity,\ STEM,\ \cos t)\ = \beta_{0\_} + \beta_1\ free\ tuition_i + \beta_2 X_i + \mu_i$$

Preference represents the variable of interest with respect to length, selectivity, STEM, or cost. Free tuition refers to free tuition in the years 2016 and 2017, and X is a vector of control variables (PSULanguage, PSUMathematics, NEM, School Rank, Mother's Education, and Gender).

It may be that a small number of eligible students did not accept free tuition. In the absence of full information, B_1 is used as an Intent to Treat (ITT) indicating the assumption that all lower income students received free tuition.

Result and control variables

Response variables

1. Selectivity. Each university was assigned a score representing selectivity, based on the proportion of applicants accepted with PSU scores above 600. Selectivity values range from 0 to 100.
2. Costs. A student's score on this variable is the average rank of programs chosen. The programs were rank ordered on the basis of their costs from 1 to 700; the higher the rank, the more expensive the program. The rankings were calculated for each of the 4 years. The use of this procedure is based on the assumption that applicants' decisions were more influenced by relative or comparative costs than by actual prices.
3. STEM. The value of this variable is the proportion of programs chosen that are STEM programs. The variable's values range from 0 to 100.
4. Length. Values of this variable range from 2 to 14, indicating the average number of semester length of programs chosen by an applicant.

Control variables

1. PSULanguage: score on the required PSU language subtest
2. PSUMathematics: score on the PSUMathematics subtest
3. NEM: score based on secondary school GPA
4. School Rank: score of secondary GPA adjusted to reflect average of school attended
5. Mother's Education: highest education level attained by student's mother
6. Gender: applicants' self-identification of gender

Results were calculated using three estimators: ordinary least squares in a multiple regression model (Wooldridge, 2010), regression adjustment (RA) (Cameron & Trivedi, 2005; Wooldridge, 2010), and propensity score matching (PSM) (Abadie & Imbens, 2016). These methods treat observable characteristics of the applicants as control variables and then compare the results of differences between the two groups (treatment and control). This permits estimation of whether students who received free tuition in 2016 and 2017 differed significantly in their preferences from those who did not receive free tuition in 2015. The three levels of effect size (eta-square of ratio of dependent to independent variability) was represented in a scale of 0.0099 (low), 0.0588 (medium), and 0.1379 (high).

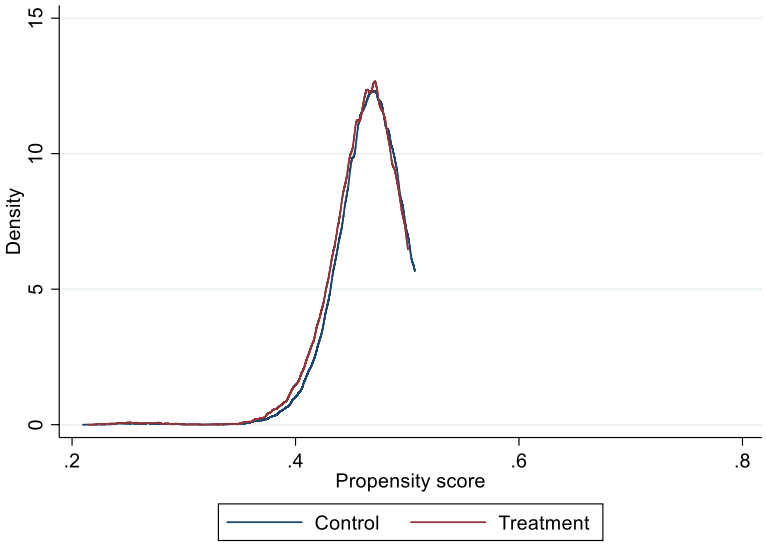
Robust standard error was used because the Breusch-Pagan and White tests indicated heteroscedasticity. The VIF test did not indicate multicollinearity. The RAMSEY was applied to test the specificity of the model, rounding out the assumptions of a regression model adjusted using OLS. Given the short time lapse between the two periods compared, it is unlikely that changes in variables biased the results. Table 1 reports values of some of the variables.

The Stata program, teffects psmatch, was used to calculate the propensity score matching (PSM). The program estimates the average treatment effect on the treated (ATET) by matching each subject to another closest in propensity score who received. A check was made to ensure that the overlap assumption, which states that each individual has a positive probability of receiving each treatment level, was met. Graph 1 shows the overlap of the processes for the selectivity outcome.Graph 1.Similarity of likelihood of selection of control and treatment subjectsGraph 1.Similarity of likelihood of selection of control and treatment subjectsGraph 1.Similarity of likelihood of selection of control and treatment subjects

A sensitivity analysis was carried out which simulated a potential confounder. This provided a test of the robustness of the estimated treatment effect with respect to specific deviations from the conditional independence assumption. There were no important deviations from the baseline (Nannicini, 2007).

Table 1 Comparison of control and treatment groups (lowest 5 income deciles)

Variable	2015	2016	2017
Gender (% women)	55.67	56.94	58.63
PSU Math (mean and sd)	545.4 (89.6)	534.1 (95.9)	531.0 (93.5)
PSU Lang (mean and sd)	550.9 (87.4)	542.1 (91.8)	538.6 (90.2)
High school GPA (mean and sd)	573.8 (95.8)	570.1 (97.5)	569.8 (98.0)
% in lowest 5 deciles	71.8	71.9	67.9
% school graduates in the previous year	60.9	62.4	59.3
School Rank (mean and sd)	605.4 (124.4)	597.3 (122.3)	597.0 (122.7)



Graph 1. Similarity of likelihood of selection of control and treatment subjects

As Table 1 shows, there were minor differences between the three cohorts of student in the study. They are small enough to support an assumption that the three groups are comparable. This situation justifies the use of the estimators mentioned above, which makes it possible to avoid imbalances between the groups under comparison when dealing with observational data.

Results

Impact of free tuition on the application profile

This section presents the results of the variables referring to the effect of free tuition, comparing lower income (lowest 5 deciles) applicants in 2015 with those in 2016 and in 2017. The 2017 cohort was included to estimate the persistence of the free tuition effect.

Selectivity

In 2016, the introduction of free tuition made very little difference in the selectivity of the universities to which students applied. Nor did selectivity have a serious influence on choice of university in 2017 (Table 2). Given the large sample size, the estimate is statistically significant but so small as to have no practical meaning.

Length of degree programs

Table 3 shows that the values of the dependent variable length of program for the treatment group are significantly different than those for the control group. Free tuition receivers were more likely to have chosen longer programs. This relationship was reversed in the

Table 2 Effect of free tuition on selectivity in 2016 and 2017

	2016				2017			Effect size eta-square
	Coef (OLS)	Coef (RA)	Coef (PSM)	Effect size eta-square	Coef (OLS)	Coef (RA)	Coef (PSM)	
Free tuition	0.0117 (***)	0.0119 (***)	0.0106 (***)	0.0013	−0.0032 (***)	−0.0031 (***)	−0.0040 (***)	0.0000
Standard error	0.0008	0.0008	0.0010		0.0008	0.0008	0.0011	
Sample size	170,609	170,609	170,609		164,450	164,450	164,450	

Table 3 Effect of reception of free tuition on length of program chosen in 2016 and 2017

	2016				2017			
	Coef (OLS)	Coef (RA)	Coef (PSM)	Effect size eta-square	Coef (OLS)	Coef (RA)	Coef (PSM)	Effect size eta-square
Free tuition	0.0860 (***)	0.0862 (***)	0.0800 (***)	0.0014	−0.1686 (***)	−0.1685 (***)	−0.1724 (***)	0.0043
Standard error	0.0056	0.0056	0.0075		0.0063	0.0063	0.0082	
Sample size	170,609	170,609	170,609		164,450	164,450	164,450	

second year, but the effect size is small. In practical terms, there is no relationship, positive or negative, between the reception of free tuition and the length of the program chosen.

STEM programs

There was no positive effect of free tuition on choices of STEM programs. The reception of free tuition by low-income students had no appreciable effect, although the slight impact is statistically significant. It is slightly more negative in the second year but still not of any importance (Table 4).

Cost of programs

Controlling on all other variables, students eligible for free tuition were much more likely to choose more expensive programs. The impact of free tuition increased in 2017, that is, the differences were larger than in 2016. The size of the positive effect was small in 2016 but larger in 2017. As Table 5 shows, the effect size was 0.0366.

Low-income applicants definitely preferred higher cost degree programs. The coefficient measuring impact was high in 2016 and, in 2017, twice as high, as compared with preferences made in 2015.

Discussion

In choosing which university program to apply to, applicants' decisions are most affected by the program's tuition costs. The availability of free tuition results in more applications for admission to high-cost programs. Other factors—length, being in the STEM field, and programs offered in a selective university—were of relatively little importance (although effect sizes were statistically significant). The effect of free tuition on preference for expensive programs is found among the general population of applicants as well as among those in the lower 50% of the income distribution. The finding that, except for cost, free tuition has little effect on the socioeconomic composition of the university student program is consistent with previous research (Billings et al., 2021; Espinoza et al., 2021; Nguyen, 2019).

Free tuition had only a small effect on choice of more selective programs in the first year of implementation. There were, therefore, factors other than tuition cost that influenced the choices of applicants to selective universities. In the second year, however, the relationship was negative but small. Free tuition recipients more often chose less selective universities. One possible explanation for this phenomenon is that applicants interpreted the offer of provision of free tuition as an indication of the quality of instruction those universities would provide. The logic of signaling theory (Spence, 1973) suggests that the establishment of free tuition increased information available to applicants and may have increased the positive image of less selective universities. Institutional image has been shown to be a relevant factor in choosing between higher education institutions (Heathcote et al., 2020; Azad et al., 2021). In Serna's (2020) perspective, free tuition has become for applicants an indirect indicator of the quality of higher education institutions.

The signaling interpretation is called into question by the students' choices with respect to the length of the program. The control group (2015) paid tuition and preferred longer

Table 4 Effect of free tuition on choice of stem programs in 2016 and 2017

	2016				2017			
	Coef (OLS)	Coef (RA)	Coef (PSM)	Effect size eta-square	Coef (OLS)	Coef (RA)	Coef (PSM)	Effect size eta-square
Free tuition	− 0.0220 (***)	− 0.0215 (***)	− 0.0223 (***)	0.0001	− 0.0457 (***)	− 0.0453 (***)	− 0.0619 (***)	0.0005
Standard error	0.0048	0.0048	0.0065		0.0048	0.0048	0.0066	
Sample size	170,609	170,609	170,609		164,450	164,450	164,450	

Table 5 Effect of free tuition on cost of programs chosen in 2016 and 2017

	2016				2017			
	Coef (OLS)	Coef (RA)	Coef (PSM)	Effect size	Coef (OLS)	Coef (RA)	Coef (PSM)	Effect size
Free tuition	75.152 (***)	75.336 (***)	76.825(***)	0.0910	151.059 (***)	151.100 (***)	151.746 (***)	0.0366
Standard error	1.7965	1.801	2.415		1.9089	1.9100	2.5728	
Sample size	170,609	170,609	170,609		164,450	164,450	164,450	

(and therefore more costly) programs, while those in the treatment years (2016–2017) preferred shorter programs. Earlier studies presented evidence that in the absence of free tuition, students preferred shorter programs (Cattaneo et al., 2020). Admittedly, the sizes of the effects in this study even though statistically significant are not large. The current finding may be attributable to the fact that free tuition replaced loans and scholarships as a source of finance of university studies. Consequently, free tuition did not change the socioeconomic profile of applicants (Arzola, 2021).

The frequency of choice of STEM programs was not changed significantly by the introduction of free tuition. This result was contrary to expectations. STEM programs are longer and are more difficult (have a higher noncompletion rate). Failing in a program financed with loans results in having to assume a large bank debt without having improved earnings. Free tuition eliminated that debt risk. The supposition that applicants would use that reasoning and more frequently choose STEM programs was not confirmed, however. This may be an indication that demand for STEM programs has weakened (perhaps as a result of labor market changes) in line with findings from other countries and regions (Eastman et al., 2017; Lytle & Shin, 2020; Sithole et al., 2017).

Of the four variables, with the implementation of free tuition, only the cost of university studies has an appreciable direct effect on the preferences of university applicants. This result can be explained by risk aversion theory (Breen & Goldthorpe, 1997; Goldthorpe, 1996) which argues that families and students prefer to avoid programs that require assuming large debt (bank loans) if there is a risk of failure. Free tuition reduced or eliminated the cost of programs and consequent risk from failure. The results showing higher preferences for high-cost programs in 2016 and higher even in 2017 confirm the hypothesis for the preferences of the 50% lower income students.

This appears to contradict the earlier speculation that free tuition functioned as a replacement for loans and government scholarships (Contraloría General de la República, 2019). An alternative view, which explains the high effect sizes for treatment group, is that while loans and government scholarships covered some of the costs of higher education, they did not cover all. Students had to finance remaining costs with loans and scholarship. Free tuition ended this copayment that may in the past acted to inhibit application.

Conclusion

This study demonstrates that free tuition, at least in the first 2 years of its implementation as a policy, has had no appreciable effect on the preferences of applicants for degree programs in terms of their selectivity, length, or inclusion in STEM, for applicants of lower family incomes. The increase in the proportion of lower income students enrolling in higher education constitutes a reduction in educational inequality.

Only one variable affects applicants' choice, the cost of the program. Introduction of free tuition resulted in an increased preference for higher cost programs, especially among lower income applicants. This conclusion is consistent with rational decision-making theory, in which applicants base their decisions taking into account the indebtedness that rises directly with the cost of the program. With free tuition, this concern disappears as cost is absorbed by the state.

Among lower income applicants, the relationship between cost and choice of program continued in the second year of implementation, indicating its persistence. Free tuition had little or no effect on preferences for programs as a function of length, selectivity, and

STEM. This may have occurred because the new policy rather than attracting new students with different socioeconomic background has mainly translated into a replacement mechanism for previous loans and scholarships. This suggests that universities could attract more students to STEM by increased contact with secondary schools.

Given the above, other policies are necessary to expand enrollments in programs consistent with the development policies of Chile, such as increased activity in Science, Technology, Engineering, and Mathematics.

Limitations and future lines of research

This study involved only those secondary school graduates who scored above 450 on the PSU admission test. Research should be done to understand the motivations and preferences of those students who did not exceed that academic barrier. Not known is the number of otherwise eligible students who did not seek university admission. Some proportion of these would have obtained PSU scores high enough to be eligible for free tuition. No research has been done on that population.

This study focused only on the effects of free tuition on choices made in applying to the university. The next step should be a study of how many students actually enrolled in the university and programs of their choice and on the academic performance and persistence of those that did. Are the trajectories of students receiving free tuition different from those who received loans and scholarships? Does the reception of free tuition affect the rate of transfer from one degree program to another, and the overall completion or graduation rate? Is there evidence of a shift in the behavior of upper income students that would result in an EMI? These and other studies will expand understanding of the role of free tuition in the academic trajectory of students who enter selective universities. This indicates the need for qualitative studies to explore how best to affect the decision process of applicants.

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Declarations

Conflict of interest The authors declare no competing interests.

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