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Cecilia Machado
Christiane Szerman

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Cecilia Machado
Getulio Vargas Foundation (EPGE-FGV)
and IZA

Christiane Szerman
CPI/PUC-Rio

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IZA

P.O. Box 7240
53072 Bonn
Germany

Phone: +49-228-3894-0
Fax: +49-228-3894-180
E-mail: iza@iza.org

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ABSTRACT

Centralized Admission and the Student-College Match*

Decentralized assignments in the education market have been increasingly replaced by centralized ones. However, empirical evidence on these transitions are scarce. This paper examines the adoption of centralized admissions in the Brazilian higher education market. Using rich administrative data, we exploit time variation in the adoption of a clearinghouse across institutions to investigate its impact on student sorting, migration and enrollment. We find that institutions under the centralized assignment are able to attract students with substantially higher test scores and that geographical mobility of admitted students increases. While there are no sizable effects on final enrollment rates, search is intensified. Overall, our findings indicate positive impacts of centralization on the college market.

JEL Classification: D47, I23, I28

Keywords: higher education, centralized matching, college admission, test scores, migration, enrollment

Corresponding author:

Cecilia Machado
Getulio Vargas Foundation
Graduate School of Economics
Praia de Botafogo 190, 11th floor
Botafogo, Rio de Janeiro 22250-900
Brazil
E-mail: cecilia.machado@fgv.br

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1 Introduction

Each year, millions of students apply to colleges through a wide variety of mechanisms. In some countries, such as Chile, Turkey, Germany, Taiwan, and the U.K., admissions are entirely centralized, and the allocation of students to colleges is mediated by a clearinghouse. In other countries, such as Japan and the U.S., admissions are decentralized, in the sense that colleges make decisions separately from each other.

In comparison to decentralized markets, it is widely believed that centralization improves coordination, reduces congestion, increases the scope of the market, and improves welfare and matches (Gale and Shapley, 1962; Roth and Xing, 1997; Niederle and Roth, 2003; Abdulkadiroglu et al., 2005, 2015). These features explain why centralized clearinghouses have long been adopted in many markets.[1] Recent research has developed specific frameworks for understanding decentralized markets in college admission and the welfare and efficiency gains of centralization (Chade et al., 2014; Hafalir et al., 2014; Che and Koh, 2016).[2] Yet, empirical evidence on the benefits of centralized matching in higher education remains surprisingly scarce.

This paper addresses this limitation by exploiting a unique and large-scale policy change in Brazil to study the effects of centralization in college admission. Prior to 2010, each higher education institution would select students based on its own admission exams. Students, in turn, were allowed to apply to as many institutions as wanted, making specific degree choices in each application. Test-score based admissions meant that institutions offered their seats to the top-scoring candidates on their admission exam. In 2010, the Ministry of Education created SISU, a centralized clearinghouse that allocates students to federal and state public higher education institutions.[3] Using scores from a nationwide exam called ENEM, students could now submit up to two program choices – where a program corresponds to a degree and institution pair – among the ones made available through the system. Final assignments were made using a deferred acceptance algorithm based on the ENEM score.

[1] In the U.S., for example, a centralized clearinghouse called National Residency Match Program determines the placement of medical students to residency options (Agarwal, 2015)). Also, in many cities in the U.S. and around the world, distinct clearinghouses have been created to assign students to schools.

[2] Chade et al. (2014) develop a decentralized model to understand the role of two application frictions – costly portfolio choices and admission uncertainty – in the college admissions. Hafalir et al. (2014) and Che and Koh (2016) characterize the equilibrium outcomes under decentralized admission.

[3] Throughout the paper, we use the terms "public institutions" and "federal and state public institutions" interchangeably.

We exploit the gradual adoption of the clearinghouse across public higher education institutions to compare outcomes within programs before and after centralization, controlling for a battery of fixed effects, state trends and covariates.[4] Since adoption was not mandatory, we validate our empirical strategy by showing that the timing of adoption was not driven by institution-specific characteristics. Our analysis sample takes advantage of rich information provided by the Brazilian Higher Education Censuses and individual-level data of ENEM test takers, linked together using restricted access identifiers. The linked dataset contains information on all first-year students ever registered in higher education institutions, their demographic characteristics (including places of birth and residence), their ENEM test-scores, and the degrees and institutions they attended.

While most demographic characteristics of admitted students remain similar after centralization, we find sizable effects of centralization on their test scores. Institutions under the centralized assignment system are able to recruit students that score one third of standard deviation higher in the ENEM exam. In addition, we find that enrolled students are more likely to be coming from a state or municipality that is different from where their program is located. Overall, market integration brought by centralization increases interstate mobility by 2.5 percentage points, which correspond to a 25% percent increase in the baseline migration rate. These effects are robust to many alternative specifications. Taken together, both findings indicate that centralization expands the scope of the market and improves the student-college match by admitting students with higher scores and from different regions of the country.

At last, we investigate effects on enrollment. The clearinghouse leads to a higher likelihood of an ever registered student not being enrolled by the end of the first year. This result, however, is mainly driven by students who cancel their registration before the end of the academic term, possibly indicating that they have opted for a preferred program elsewhere and that the same seat was subsequently occupied by another candidate. We find small effects of a registered student being on leave and no effects on the occupancy rate of seats. We interpret these findings as a rise in the turnover rate of seats available in the clearinghouse, with very little impacts on enrollments. We note this finding is specific to the

[4]In 2010, the first year of the new centralized mechanism, nearly 25% of all Brazilian public institutions joined it, and more than 64 thousand seats were made available in the system. In 2014, the last year of our period of analysis, about 50% of public institutions already adopted the centralized clearinghouse by offering almost 225 thousand seats in the system.

Brazilian context, as will be later described.

Our work speaks to three strands in the literature. First, application costs and admission uncertainty are important determinants of students' application decisions (Fu, 2014; Chade et al., 2014). In the U.S., for example, college application has been shown sensitive to financial aid and applications assistance (Bettinger et al., 2012), to information about colleges and programs (Carrell and Sacerdote, 2013; Hoxby and Turner, 2013) and even to small changes in application costs (Pallais, 2015). In the setting of our study, the centralized system alleviates several costs by providing online information on majors, campus and institutions, as well as daily updates on cutoff admission scores. Monetary costs are also considerably reduced as one application fee for taking the ENEM exam serves the purpose of several applications. In addition, the SISU platform itself is free of cost. The combined reduction of search, time, monetary and information costs further enhances the reach of the centralized admission system under study.

Second, there is now growing evidence of both under- and overmatch between students and colleges (Dillon and Smith, 2016). The literature has documented that low-income high-achievers undermatch more often then their high-income counterparts because their applications decisions are sensitive to information acquired by peers in the same geographical location (Hoxby and Avery, 2014; Hoxby and Turner, 2015). Market scope also plays a role for academic mismatch, which generally results from restricted admission and affirmative action policies (Arcidiacono et al., 2011; Sander and Taylor, 2012; Black et al., 2015; Arcidiacono and Lovenheim, 2016). Our results suggest that market integration improves the matches between students and institutions. Since college quality is strongly associated with college completion rates (Cohodes and Goodman, 2014), improvements in the student-college match could have lasting effects on educational attainment and labor market returns of the affected cohorts.

Third, this paper also relates to the literature that studies the effects of centralization and coordination in other markets. Niederle and Roth (2003) find that the implementation of a centralized clearinghouse for gastroenterologists increased mobility by widening the scope of the market. Abdulkadiroglu et al. (2015) show that the introduction of a coordinated centralized assignment enhances students' willingness to travel, in comparison to the old uncoordinated mechanism, even though daily commutes are costly to school students. Our results are the first to focus on the college market and, specificities apart, remain consistent

with the existing empirical evidence.

This paper proceeds as follows. Section 2 describes in details the Brazilian higher education system and the introduction of a large-scale policy that created a centralized clearinghouse to allocate students to colleges. We also discuss the expected effects of centralization on student sorting, migration and enrollment. Sections 3 and 4 outline the data and the empirical strategy, respectively. Section 5 presents the main results. We conclude in Section 6.

2 Institutional Context

2.1 Higher Education in Brazil

The Brazilian higher education system consists of 2.368 private and public institutions of distinct characteristics and quality levels. Among them, 298 are public institutions administered by the federal (107 institutions), state (118) or municipal (73) governments. Private institutions are either for-profit or non-profit organizations, and for-profit institutions take a larger share of the market. Institutions offer bachelor and licentiate degree programs, which take on average 4-6 years to complete, and technological degree programs, which last on average 2-3 years.

Public institutions do not charge tuition fees in most cases, with the exception of municipal institutions.[5] They offer a limited number of seats and are generally perceived as having the best and most selective programs, leading to intense competition in admission.[6] Admissions to private institutions, in contrast, meet a lower standard. Tuition fees are high on average and impose a financial burden to low income families.[7]

Similar to Chile, Brazilian students choose their majors at the application stage (Hastings et al., 2013; Bordon and Fu, 2015). Admission is exclusively based on entrance exam scores and does not depend on high school GPA or subjective assessments, such as recommendation

[5]The Brazilian Constitution bans tuition fees in public institutions, including those administered at the municipal level. However, some municipal public institutions still charge fees under the argument that they are not entirely financed by public funds. There is an ongoing legal debate of whether tuitions can indeed be charged by municipal institutions.

[6]Between 2010 and 2014, the share of seats in public institutions has ranged from 22 to 16 percent (2010-2014 Higher Education Census).

[7]Monthly tuition fees are about 645 *reais*, equivalent to 89% of 2014 minimum wage (Hoper Educação, 2014).

letters. Each year approximately 3 million first-year students are enrolled in higher education programs.[8]

Prior to 2010, admissions were completely decentralized. Students directly applied to each institution and had to take an specific entrance examination, known as *Vestibular*.[9] Students could apply to as many institutions as wanted, but all applicants to a given institution would take the *Vestibular* exam at the same date and time.[10] Only top-scoring applicants to each program were offered a seat. A single student could be admitted to several programs and be enrolled in more than one at the same time. Any remaining vacant seats would be gradually offered to wait-listed applicants according to their rank.

Aiming to improve fair access to public higher education institutions, the Ministry of Education introduced a series of reforms starting in 2008. Most importantly, there was the reformulation of the secondary education assessment exam (henceforth, ENEM), taking place in the 2009 edition, followed by the creation of a centralized admission clearinghouse (henceforth, SISU), in January of 2010.

2.2 The ENEM exam

Created in 1998, the ENEM exam was formerly conceived to be a non-mandatory one-day exam to evaluate secondary schooling. Indeed, since its inception, the exam has been widely used in schools' league tables to inform about the quality of secondary schools (Camargo et al., 2014). Prior to its reformulation, the old ENEM was regarded as a problem-solving and critical analysis assessment, rather than a rigorous curriculum-based examination. It consisted of 63 multiple-choice questions from a range of subjects and a written essay.[11] Perceived as a less rigorous assessment than *Vestibular*, the old ENEM exam was virtually irrelevant for most admission procedures in public institutions, but it was used for admission

[8] Source: Higher Education Census, 2010-2014.

[9] Institutions are free to design their own entrance exams. Some follow a pattern with two phases, in which the first phase consists of multiple-choice questions and the second phase comprises written questions – specific to the chosen degree – and essay. Others have a single-stage exam with scores weighted by major choice.

[10] The *Vestibular* exams are typically scheduled once a year, in the second semester of the year that precedes admissions. Since the academic term goes from February to December, the exams are scheduled between October and January. If two or more *Vestibular* exams are scheduled at the same day and time, only one can be taken.

[11] The subjects are Biology, Chemistry, Geography, History, Math, Physics, and Portuguese.

in many private institutions.[12]

In addition, ENEM scores are also used for granting scholarships in private institutions to low-income students through the PROUNI program.[13] Created in 2004, PROUNI offers fellowships to top-scoring applicants. Cutoff scores depend on the number of seat made available for PROUNI in each program. In 2016, more than 328 thousand PROUNI scholarships were offered. Since admission to public institutions is highly competitive and uncertain, the large majority of college applicants had great incentives to take the ENEM exam even before its reformulation in 2009.

In 2008, the Ministry of Education announced that the ENEM exam would become more content-based and rigorous to boost its use as the only entrance examination by higher education institutions, especially public institutions. With 180 multiple-choice questions and a written essay, the new structure resembles the most competitive *Vestibular* exams. To take the ENEM exam, applicants have to pay a registration fee of approximately USD 20 (or 68 *reais* in the 2016 edition). In some cases, payment exemption is allowed.[14] The exam is simultaneously taken once a year, at the end of the academic year, across the country.[15] Item response theory is also used in the calculation of the final scores to allow for comparability of ENEM scores from 2009 onwards.

Although the ENEM exam remains optional to high school students, its reach is remarkable. In 2014, the total number of applicants reached a record high of nearly 8.7 million. The expansion is striking when compared to only about 157.221 students registered to the first exam, in 1998. Figure 1 illustrates the evolution in the number of test-takers and highlights two noteworthy jumps. The first, in 2004, is attributed to the creation of the PROUNI

[12]Very few public institutions adopted the ENEM scores in their admission procedures. Some notable exceptions were the State University of Campinas (UNICAMP), the University of São Paulo (USP), and the Federal University of the State of Rio de Janeiro (UNIRIO). ENEM scores compound the first phase of UNICAMP and USP admissions since 2000 and 2003, respectively. Between 2007 and 2009, UNIRIO allocated half of spots to admit students exclusively through ENEM scores.

[13]In addition to taking the ENEM exam, PROUNI applicants have to comply with one of the following criteria: having completed high school education entirely in public high school; in private high school with full scholarship or any combination of these two requirements; being disabled; or being a teacher in public schools. Full and partial scholarships are awarded to applicants based on their *per capita* monthly household income. The thresholds are defined as lower than 1.5 and 3 minimum wages, respectively. Applicants submit their ENEM scores and choices to the PROUNI online platform.

[14]Payment exemption is allowed for students: a) who graduated from a public high school; b) who had completed high school education in a public school or a private school with full scholarship and have *per capita* monthly family income lower than 1.5 minimum wage; or c) whose families have *per capita* monthly income lower than half of the minimum wage or total family income lower than 3 minimum wages.

[15]The exam is generally scheduled for late October or early November.

program. The second jump, in 2010, is primarily driven by the implementation of the SISU system.[16]

2.3 The SISU System

After its reformulation, ENEM scores were gradually incorporated into the admission criteria of many private and public institutions. To facilitate its use exclusively by public and tuition-free institutions, the Ministry of Education created SISU (*Sistema de Seleção Unificada*) in January of 2010.[17] Using ENEM scores as the only metric to rank candidates, SISU is an online platform that allocates students to public institutions.

While SISU was made available to all public tuition-free institutions, its adoption was not compulsory. Institutions could decide whether they would offer their seats through SISU and how many seats would be offered for each degree. Some few degrees that require very specific skills prior to admission (e.g. Music, Performing Arts, and Visual Arts) could still admit their students through the traditional *Vestibular* exams, even when their institutions have opted for taking part in the SISU system. The Ministry of Education, in turn, encouraged institutions to move to a centralized system by providing them additional monetary transfers.[18]

The number of available seats in SISU is publicly announced at the beginning of each of its edition, in the months before the start of the academic semesters, January and July. However, the majority of spots are offered in the January opening, even for programs that

[16] It is important to mention that ENEM also became required to apply to financial aid from the Financial Fund for Higher Education Students (FIES) in 2010. However, only applicants graduating from high school from 2010 onwards were required to take the ENEM exam, with no minimum score. In 2015, FIES starts requiring the ENEM exam in the year of application for all applicants, including high school graduates before and after 2010. A minimum score in ENEM (450 out of 1000) was also stipulated in the same year.

[17] Another important policy to improve access to higher education was the prohibition that two or more seats in public institutions being occupied by the same student (Law 12.089, created in November of 2009). Until then, a student could be enrolled in more than one institution at the same time. Anecdotal evidence suggests that this situation was not unusual. The new law aimed at increasing the relative supply of seats in public institutions, since students were no longer allowed to be enrolled in a less preferred option once matriculated in a more preferred one. It preceded the creation of SISU.

[18] In 2010, the Ministry of Education created both PNAES (the National Program of Student Assistance) and PNAEST (the National Program of Student Assistance for State Public Higher Education Institutions), which are programs that guarantee resources for student assistance in state and federal public institutions, respectively. For state public institutions, the transfers were proportional to the number of seats made available through SISU. For federal public institutions, there was no such explicit conditionality. Since federal institutions are funded by the federal government, alignment with the Ministry of Education is desirable for receiving transfers.

start in the second semester. The registration is online and free of charge. Only candidates who had taken the ENEM exam in the previous year are able to register in the platform in the current year. The registration period lasts four or five days. Over that period, applicants can choose up to two ranked degree-institution pairs (hereafter, programs) from the options offered in the system. The platform also allows for differential competition (and consequently differential admission scores) for seats reserved for affirmative action policies.

Admission cutoff scores depend both on the number of seats made available in SISU and on applicants' preferences. Previews of cutoff scores are made available online for all candidates based on the choices registered until the previous day. Candidates can change their choices as many times as they wish while the system is open, and only the last confirmed choice is valid. When the system closes, it assigns applicants to programs through a deferred acceptance algorithm. Candidates are accepted to their most preferred program under which they qualify. The result of the assignment mechanism and the list of admitted candidates are published online. All applicants are informed about their classification on the list. Appendix I provides further details of the system.

By 2008, when the Ministry of Education announced the ENEM reformulation, many institutions were still skeptical about its new and selective content and about the practical management of an exam of such importance.[19] However, both ENEM and SISU have built a solid reputation over time, and more institutions increasingly joined the centralized assignment mechanism. In the first year of SISU, 59 out of 178 federal and state public institutions adopted the system. From 2010 to 2014, SISU adoption rapidly increased, both in number of institutions and in number of available seats.[20,21]

In sum, after 2010, public institutions experienced a broader range of options to admit students. At present, four non-exclusive admission metrics are available: *Vestibular* scores only, some combination of ENEM and *Vestibular* scores, ENEM scores without the SISU platform, and ENEM scores through the SISU platform.[22]

[19] This skepticism considerably worsened with the leaking of the 2009 exam, an episode which was followed by a rescheduling of the exam to a later date.

[20] Figures 6 and 7, Appendix II, depict these patterns. In 2010, approximately 25% of public institutions joined it. More than 64 thousand seats were offered in the system. In 2014, about 50% of public institutions already adopted SISU and almost 225 thousand seats were made available in the system.

[21] To name few examples, the Federal University of Rio de Janeiro (UFRJ), in 2011, and the University of Brasília (UnB), in 2014, partially joined the system. Since 2012, the Federal University of Rio de Janeiro only admits students through SISU.

[22] In 2014, all federal universities used ENEM scores to select students by joining the SISU system, by incorporating the ENEM score into the overall grade in the *Vestibular* exams without SISU or by employing

2.4 Theoretical Discussion

Before turning to our empirical strategy, which exploits the gradual adoption of SISU across public institutions in Brazil, we discuss the expected first-order effects of centralization on students sorting (measured by test scores), migration and enrollment.

2.4.1 Test Scores

While deviations in academic assortative matching are common in higher education, students' application and enrollment decisions are key drivers of such result. Therefore, rules, regulations and procedures in admissions are critical to enhance competition among applicants, improve the quality of the entering cohort and reduce college mismatch.

In a theoretical framework, Che and Koh (2016) analyze the consequences of a centralized college admission that uses a deferred acceptance assignment. The authors show that, although centralized admission leads to efficiency and fairness, it does not necessarily imply that all colleges will be better off. Some colleges may be worse off because they no longer attract some goods students they used to get under the decentralized admission. In a centralized setting, students will be assigned to the best colleges for which they qualify to, with no justified envy among them. Cutoff admission scores will exhibit a monotonic pattern and only the top-scoring students are enrolled.

The introduction of SISU platform not only coordinates assignments across participant institutions, but also facilitates the application process for students. Search costs are considerably reduced due to the availability of a friendly interface that gathers information on the available majors, institutions, and campus location.[23] In addition, monetary and time costs are lowered because applicants only need to one exam serving multiple purposes, instead of bearing many application fees and taking many admission exams.[24]

These new features are expected to change application decisions and move prices (measured by admission cutoff scores) in the direction of the aggregate and nationwide demand. In the Brazilian case, switching to SISU is only possible for federal and state public in-

the ENEM score as first phase or bonus for admissions through *Vestibular*. In January of 2015, only five out of sixty-three federal universities did not select students through SISU.

[23] In the U.S., the Common Application is an example of an online instrument that facilitates the search and college application process.

[24] Pallais (2015) shows that students are sensitive to monetary costs in the college application decisions. When they were allowed to send an extra free application, they applied to more colleges and low-income students attended more selective colleges.

stitutions, which are perceived as high quality institutions in the country. They are also tuition-free, which allows them to attract students regardless of their incomes or willingness to pay. Thus, centralization is expected to increase competition and the sorting of admitted students. If seats in public institutions are in high demand, admission scores should increase for them.

2.4.2 Migration

Before SISU, public institutions operated in local markets, serving mainly its local population. In most cases, exams were taken near the place in which institutions were located, which severely limited the geographical scope of applications. Moreover, applicants would need to gather information about the application rules (dates and requirements) on a case-by-case basis. With centralization, the scope of the market is increased, allowing public institutions to recruit nationally. While SISU alleviates many geographical barriers, migration in not a foregone conclusion.

Although public higher education institutions are tuition-free, subsistence costs, which include room and board, can be sizable in a context in which credit lines and loans are not easily available. An additional factor is the sizable dimension of the country. We empirically investigate which effect dominates.

2.4.3 Enrollment

Seats offered by public institutions are in fixed supply. They are only made available to candidates ranked in the waitlist after have been declined by previous occupants. While capacity constraints are met by design – rendering subscription beyond the target impossible –, there are still concerns about undersubscription: seats left unoccupied by the end of the academic term are still paid for by public funds.

College quality has lasting effects on persistence. If matches are improved with centralization, enrollment rates by the end of the first-year could increase. In our data, however, enrollment rates of students ever offered a seat are substantially high (85-89%), and it is possible that SISU does not operate on this margin. More interesting is the effect of centralization on the seat turnover rate, which we will measure as the likelihood of an ever existing registration being cancelled (in this case, the seat is left vacant for the next top-scoring applicant). As search costs go down, we expect turnover to increase.

3 Data

In this paper, we use two annual administrative datasets, the Brazilian Higher Education Census and the ENEM databases. The Higher Education Census provides a comprehensive overview of all higher education institutions in the country, with information about their graduation programs, technical-administrative staff and instructors, as well as individual demographic information on each student matriculated in higher education institutions. The ENEM database contains detailed information on test-takers' scores, along with demographic characteristics and questionnaires. We have gained restricted data access to students' identification numbers available in both datasets, which allows us to link them.[25]

We make the following sample restrictions in the Census. First, we limit the analysis to the 2010-2014 Census because reliable individual information started to be reported in 2010 and the most recent available year is 2014.[26] Second, we exclude private and municipal public institutions because they cannot join SISU, as only public and tuition-free institutions are allowed to participate in the platform. Third, we drop observations from online education programs. Fourth, we restrict our sample to first-year students. Our analysis focuses on the short-run, but first-order, effects of SISU on first-year students because they are still too young to graduate by the last year of our data. After these restrictions, our final sample consists of five cohorts of first-year students – with 2.167.313 individuals – admitted between 2010 and 2014 to federal and state public institutions. We refer to this sample as the Census baseline sample.

We link Census data in a given year with ENEM data in the previous year, since these test scores can be potentially used for college admission. Thus, the ENEM data of interest ranges from 2009 to 2013. Our linking variable is the Brazilian Taxpayer Registry, a number that is uniquely assigned to individuals in the country and is used for tax collection purposes and for social security claims.[27] The advantage of integrating both datasets is twofold. First, we can identify ENEM test score of students enrolled in higher education institutions. Second, while Census data identify students' place of birth, ENEM data provides information on

[25] Data access was provided by the National Institute for Educational Studies and Research (INEP).

[26] Individual information started to be collected in 2009. Prior to that year, information is only available at more aggregate levels. However, the Brazilian Taxpayer Registry, which is the identification number we use to link the ENEM and Census datasets, are only reported from 2010 onwards. Discussions with the INEP staff indicate that the inclusion of the Taxpayer Registry is essential to build a reliable link between the Census and the ENEM datasets.

[27] We refer to the *Cadastro de Pessoas Físicas* (CPF) as the Brazilian Taxpayer Registry.

place of residence at the time when the exam is taken. Both locations will be considered when measuring students' mobility. We are able to match about 71% of the Census baseline sample to the ENEM datasets.[28,29] We refer this sample as the Census-ENEM matched sample.

Thus, the Census-ENEM matched sample contains information on all first-year students in federal and state public institutions registered in on-campus programs, along with information about the program itself (e.g. degree, institution, geographical location, whether and when it adopted SISU, etc.) and several demographic characteristics of students (e.g. tests scores, place of residence before college admission, etc.).

The three outcomes studied were generated in the following way. ENEM test scores were standardized to have zero mean and standard deviation of one across all test takers in each year. Migration dummies indicate whether the place of residence (or the place of birth) is different from the place where the program is located.[30] We use geographical location measured both at the municipality and state levels to capture inter- and intra-state migration patterns. Enrollment outcomes are measured among all ever registered students in the Census, and indicate whether students have had their registration canceled or requested leave of absence by the end of their first year. We refer to them as inactive students. Since canceled registrations likely indicate that the seat was subsequently occupied by another student, we will also consider both categories separately, as well as the likelihood of being on leave in the restricted sample of students either enrolled or on leave by the end of the year. Further details about the data and variables are described in the Appendix III.

Our research design exploits the gradual transition from decentralization to centralization made possible by SISU. Our third data source consists of information on when (and if) programs and institutions joined SISU. We add this information to our samples.

Table 1 reports annual descriptive statistics for final analysis sample from 2010 to 2014.

[28]More precisely, 1.539.008 out of 2.167.313 students. These individuals are matched using the Brazilian Taxpayer Registry, which is compulsorily reported in both datasets. Matching rates increase over time due to growing importance of the ENEM exam and are shown in the Appendix III. Unmatched individuals correspond to individuals who did not take the ENEM exam and have enrolled in higher education institutions using *Vestibular* scores only.

[29]Our matching procedures indicate that we are able to recover test score information of at least one student in 35.420 out of 37.462 (95%) program-year combinations of our sample. This allows us to infer the average ENEM scores for programs that do not require ENEM scores for admissions and reflects the exam's growing importance to students.

[30]Information of birthplace is available in the Census datasets for nearly 70% of first-year students (that is, 1.517.614 out of 2.167.313 individuals).

We observe two noteworthy patterns. First, we notice a rapid increase in the number of first-year students admitted under affirmative action policies. The share of first-year students benefited from quota systems grows from 12% to 28%. Second, less students are admitted through *Vestibular* exams over time (the fraction decreases from 77% to 39%), while more students are admitted through ENEM exams (the proportion goes from 22% to 51%). This pattern reflects the rapid expansion of the system over time.

4 Empirical Model

4.1 Empirical Strategy

To investigate how the introduction of a centralized admission system affects scores, migration, and enrollment of first-year students, we estimate the following equation:

$$Y_{ipt} = c + \beta SISU_{pt} + \delta X_{it} + \gamma X_{pt} + \alpha_p + \alpha_t + \alpha_s * t + \varepsilon_{ipt} \quad (1)$$

where Y_{ipt} is the outcome for student i registered in program p in year t, and $SISU_{pt}$ indicates whether program p (partially or fully) adopted the SISU system in the year t. The regression also includes year and program fixed effects, α_t and α_p. Year fixed effects control for common shocks that affect all students each year, whereas program fixed effects control for time-invariant characteristics of programs that might be correlated with the outcomes of interest and the decision of adopting a centralized admission. To capture unobserved state characteristics that evolve over time, we add state linear time trends, $\alpha_s{}^*t$. Standard errors are clustered at the institution level.[31]

We introduce student- and program-level control variables in the baseline regression, which are represented by the vectors X_{it} and X_{pt}, respectively. Individual controls include gender, age, race, a dummy for disability, and indicator variables for affirmative action

[31] Clustering standard errors at the institution level, rather than program level, is a more conservative specification. Our findings remain robust to specifications that replace program fixed effects by institution fixed effects and consider the transition from a decentralized to a centralized admission for institutions. These results are available upon request.

admission through quota policies and for whether the student receives social support.[32,33] Program-level characteristics barely vary over the study period. To ensure that our estimates are not driven by supply side effects, we include the annual number of seats available in each program.[34]

We take the effects on admission scores as the primary consequence of centralization and recognize that any measured impact on migration and enrollment status could be mediated by this margin of selection. Therefore, we will further consider including ENEM scores as regression controls when looking at those two outcomes.

4.2 The Adoption of SISU

Our empirical strategy relies on the assumption that the timing of the adoption of a new centralized clearinghouse is exogenous with respect to the outcomes of interest, conditional on programs and students' characteristics and program and year fixed effects. We note that our baseline regression performs a *within*-program analysis by comparing each program to itself before and after centralization. Thus, any concern related to fixed program (and institution) characteristics influencing the decision to move to a centralized admission is fully addressed by this empirical strategy.

A possible threat to our specification would be the existence of some unobservable time-varying factors that affect the adoption of the SISU system. We argue that this concern is likely unfounded for two reasons. First, institutions were equally offered the same incentives

[32]The inclusion of an indicator for quota admission is of particular importance because affirmative action policies rapidly expanded in recent years. Prior to 2012, they relied on few and independent initiatives of institutions and local governments. They started taking place in 2002, when two public universities from Rio de Janeiro (UERJ and UENF) and one from Bahia (UNEB) decided to introduce a system of quotas to admit students (Assunção and Ferman, 2011). It was followed by one university in Brasília (UnB) in 2004 and one university in São Paulo (UNICAMP) in 2005 (Francis and Tannuri-Pianto, 2012; Estevan et al., 2016). In 2012, the enactment of a federal quota law mandated that half of the seats in federal institutions to be reserved to affirmative action candidates until 2016. The implementation of affirmative action policies remains optional for other institutions, including state public institutions. Ever since, many public institutions have started reserving some of their seats for students from public schools and low-income families, including those who are African or indigenous descent.

[33]Social support comprises food, housing, and material support, among others.

[34]The expansion of the number of seats available in federal public institutions started in 2007 with REUNI (Support Program for the Restructuring and Expansion of Federal Universities). Specifically designed for federal universities, this initiative aimed boosting college access and retention by increasing the number of undergraduate programs and spots, building new campuses in remote areas, hiring more lecturers, and renovating existing built structure. In 2008, the second year of the program, nearly 98% of federal universities agreed to join this new initiative. Given that this program was largely adopted and preceded SISU, we expect this expansion to be uncorrelated with SISU adoption.

and compensations to join SISU. Second, while joining the system could have depended on specific perceived benefits, moving to a centralized admission hinged on majority agreement of voting members of the institution's council (generally composed by the dean and department chairs). A common argument in favor of SISU was the fairness and efficiency that centralized mechanism entails to applicants, whereas a prominent argument against was the loss of autonomy in recruiting students. In many cases, voting was heated and tight. Thus, our strategy exploits the nearly random approval by the institutions' councils.

We test for institution selection by checking for pre-centralization differences in observable characteristics. We compare several characteristics in 2009 between institutions that have ever adopted and those that have never adopted SISU over the study period. Table 2 displays that adopting a centralized mechanism is not associated with the majority of institutions' characteristics at conventional levels of significance.[35] We notice, however, few important differences. As expected, federal institutions are more likely to join the SISU system. Unsurprisingly, they are also larger (with a higher number of students and instructors) and more likely to have BA degree programs, which are features strongly correlated with federal public institutions. These differences are accounted for by the inclusion of program fixed effects. In addition, previous findings in Szerman (2015) suggest that our results are not sensitive to considering federal and state institutions separately.

We also note that institutions located in the Brazilian southeast region, which is one of the five administrative regions in Brazil, are less likely to adopt the SISU system. This region hosts the largest cities and labor markets in the country. The inclusion of program fixed effect absorbs region and state fixed effects. Nonetheless, since evolving state conditions could confound the effects of SISU adoption, we include state specific trends.

4.3 Indirect Effects

While changes in admission standards are the expected first order effects of centralization, tests scores could also go hand in hand with other students' characteristics. Therefore, before turning to our main results, we examine whether the introduction of SISU changes the composition of students in several observable dimensions. We estimate Equation (1), in

[35]Students' birthplace information is not available in the 2009 Census. In Table 2, the migration indicator corresponds to whether the birthplace is different from the place where the program is located for a sample of second-year students in the 2010 Census.

which the set of controls X_{it} are the outcome variables. Table 3 reports the results.

Overall, we find weak evidence of student selection based on observable characteristics, with the exception of age and gender. The positive effect on age is expected because retaking the ENEM exam, which takes place only once a year, is possible. As for gender, evidence in the literature suggests that women are more risk-averse than men and perform relatively worse under competition (Gneezy et al., 2003; Niederle and Vesterlund, 2007). The negative coefficient indicates that girls are more responsive to centralization. Nonetheless, both effects are economically small. Columns (7) and (8) confirm that students are more likely to be admitted using ENEM test scores with SISU, rather than using *Vestibular* scores.[36]

At last, we also examine changes in program size, measured by the number of seats offered by each program, X_{pt}. We find weak evidence of supply side effects, although the small coefficient is statistically significant. Nonetheless, we include all these variables as controls, but do not expect results to change with their inclusion.

Table 3 suggests that there were no systematic changes in students' and programs' observable characteristics after the introduction of SISU. Thus, any effect on student sorting, migration and enrollment can be attributed to centralization rather than changes in student composition or program characteristics along the above dimension.

5 Results

5.1 Effects on ENEM Scores

In Brazil, public institutions are perceived as having high quality programs. Therefore, we expect them to attract better students after adopting SISU. Table 4 documents the findings on student sorting. Column (1) reports the estimates for the model with no controls and finds a positive relationship between test scores and the adoption of SISU. Adding program and year fixed effects in Column (2) indicates that the within-program comparison is even stronger. Columns (3) and (4) include individual and program level controls, respectively.

[36]To reinforce that our results are not driven by student selection, we consider an additional set of students' characteristics, gathered from ENEM questionnaire. We estimate Equation (1) with different dependent variables, including parental education, family income, and length of school education. Table 9, Appendix IV, indicate that other observable students' characteristics are not affected by the implementation of SISU, except for a smaller fraction of first-year students with family income lower than one minimum wage (at the 10% level of significance) and from non-urban areas. Albeit significant, these estimates are quantitatively negligible.

Results barely change, consistent with those characteristics being uncorrelated with SISU adoption, as documented in the previous section.

State specific trends are considered in Columns (5) and (6), reducing the point estimate by less than 10 percent. Column (5) displays the specification with all fixed effects and state trends. Column (6) is our preferred specification with all controls. We find that the introduction of a centralized assignment leads to an increase by 0.302 standard deviations of the ENEM score distribution.[37]

Finally, it is important to note that our sample includes all students ever enrolled as first-year students, regardless of their registration situation by the end of the academic year. Column (7) restricts the sample analysis to students that are enrolled by the end of their first year. We find similar effects, indicating that dropouts are in great part high achievers moving to preferred programs.

5.2 Effects on Migration

We next turn to investigate the effects on migration. Table 5, Panel A, presents the results for interstate migration, using the ENEM-Census matched sample. In this case, migration is related to the place of residence when ENEM is taken. The within-program estimate in Column (2) indicates a higher likelihood of migration after introducing a centralized admission by 5.8 percentage points (p.p.). However, the effect is halved once individual level controls, particularly the ENEM score, are added. Column (3) reveals that applicants with higher scores are more likely to migrate, as they bear higher gains from higher education. Once we control for scores, the effect of SISU on migration is reduced to 2.4 p.p. and remain stable with the inclusion of program controls and state trends, as shown in Columns (4) and (5). In Column (6), we restrict the sample to students who remain enrolled until the end of their first year. The lower coefficient among enrolled students (2.1 p.p.) indicates that migration effects are higher for the dropout sample and highlights that migration costs are

[37] The overall effect, however, does not inform which areas of knowledge experienced a higher increase in scores. Institutions are granted flexibility to place different weights on areas of knowledge to calculate the composite score for each program. This discretion allows programs to attract students with a better fit. For example, medical programs commonly set a greater weight on Natural Science and engineering programs could value Math more heavily. When we run Equation (1) separately for each knowledge area, we find that essay scores have a larger increase in scores – the estimated coefficient is 0.359 SD. This effect is noticeable when compared to the increase experienced by other areas, which ranges from 0.184 to 0.203 SD, and suggests that a substantial weight is placed to the only area without multiple choice questions. These findings are available upon request.

not negligible for persistence in higher education.

Table 5, Panel B, displays the results for alternative migration measures. Column (1) just repeats our preferred specification in Column (5) of Panel A. We start by considering migration defined at the municipality level in Column (2), and find lower, but still positive and significant effect (1.4 p.p.), indicating that moves across municipalities were common even before SISU. Selective migration before college is also of concern, as students might already have located near the places where they want to live at the moment when they take the ENEM exam. Therefore, we also examine results that rely on birth place information available in Census data. In Columns (3) and (4), we consider results using the matched ENEM-Census sample and controlling for ENEM scores. In Columns (5) and (6), we consider the Census baseline sample without controlling for ENEM test scores.

Two striking patterns emerge. First, results are nearly identical across Columns (3) and (5) (as well as Columns (4) and (6)). Controlling for ENEM scores is mainly irrelevant for migration from place of birth. This evidence enhances the argument for the use of place of birth being more exogenous. Second, as one would expect, migration results are larger at lower levels of geographical areas. This again reinforces selective migration is at play when defined according to place of residence. Overall, results based on place of birth indicate a sizable and statistically significant effect on student mobility, ranging from 2.9 p.p. to 3.1 p.p. for interstate migration and 3.3 p.p. to 3.4 p.p. for cross-municipality migration. We note, however, that birth place information is missing for 70% of students in the Census baseline sample.

The implied travel distance given by Columns (2), (4) and (6) are 26.5, 28.9 and 31.2 kilometers, respectively.[38] Since migration likelihood only changes by 3 p.p., the distance incurred by students that actually move is as large as 1.000 kilometers (or equivalently, a little less than the distance between Rio de Janeiro and Brasília).

Our findings are consistent with Niederle and Roth (2003) and Abdulkadiroglu et al. (2015). Niederle and Roth (2003) find that the implementation of a centralized clearinghouse in the gastroenterology medical market increased mobility by widening the scope of the market. In the school choice context, Abdulkadiroglu et al. (2015) show that a centralized assignment system enhances students' willingness to travel, in comparison to a previously

[38]Results are available upon request. We estimated similar specifications replacing the migration indicator by distance between the centroids of the source and receiving municipality. If those were in the same municipality, distance was considered as zero.

uncoordinated mechanism, even though daily commutes are costly to school students. Our findings suggest that college admission is more closely related to the medical market, since tertiary students face fewer restrictions to migrate than school students.

Furthermore, the results have relevant policy implications. Recently, many countries have implemented policies to attract college educated workers (Guellec and Cervantes, 2002; Groen, 2004). One recurrent argument to justify these interventions is that attending college in a specific state might increase the probability of remaining in the same state after graduation (Fitzpatrick and Jones (2012)). However, our findings show that application costs hinder mobility in the college market and that a centralized assignment helps to reduce these frictions by mitigating geographical constraints.

5.3 Effects on Enrollment

At last, we look at enrollment status of ever registered students by the end of the academic year. On the one hand, improved matches between students and the programs they are enrolled at could translate into higher persistence rates. On the other hand, admitted students are now also more likely to be coming from more distant places. Thus, migration and subsistence costs could act as countervailing forces.

Results are displayed in Table 6. Column (1) considers the likelihood of an ever registered student being inactive either because her initial registration has been cancelled or because she is on leave of absence. It shows that inactivity increases by 4.3 p.p. with SISU. In Column (2), we confirm that the coefficient remains robust when we consider the Census baseline sample (and no test score control).

We note, however, that there is an important difference between registration cancellation and leave of absence status. While requesting a leave of absence allows students to re-enroll at the program at a later date, a registration cancellation implies the seat is left vacant to another student.[39] We therefore consider the two enrollment status separately in Columns (3) and (4). The results indicate that the previously found effect on inactivity is mainly driven by canceled registrations. Since the test score effects of SISU on inactive students are even higher than on enrolled students (Table 4, Columns (6) and (7)), we speculate that students who have had their registration canceled have opted for another preferred

[39]Re-enrollment after a leave request is subject to internal rules defined by each institution. In general, students can request to be on leave only after completing one semester.

program.[40] In Column (5), we drop canceled registrations from the sample, and the results on leave of absence remain very small, in spite of being statistically significant. Nonetheless, in Column (6), we consider an alternative seat vacancy measure, generated as 1 minus the ratio of the number of enrolled students by the end of the year and the total number of seats available in the program. We find no effect on seats left vacant through this alternative measure.

In sum, centralization increases the turnover rate of seats available through the system, as a same seat is occupied by other students beyond its last holder. Moreover, final enrollment rates are not affected by SISU. The last finding is unsurprising in the context of Brazil, since public institutions are in high demand and are able to recruit candidates in a wait-list until all seats are occupied.

5.4 Winners and Losers?

A natural extension to our results is whether and how the impacts of centralization differ across programs according to their different levels of selectivity and fields of study. To do so, we combine the 2009 ENEM microdata with the 2010 Census to recover the average ENEM scores of first-year students from programs listed in the 2010 Census. We divide these scores into quartiles to obtain a proxy for programs' selectivity. Thereafter, we estimate Equation (1) by quartile, in which first quartile faces the smallest and fourth quartile faces the largest average ENEM scores.[41] Table 7 presents the results. We find similar and homogeneous effects in all quartiles, suggesting that centralization tends to yield improvements to all programs, regardless of their selectivity.

Furthermore, we test for heterogeneous effects across fields of study. Following the international classification of fields of education and training, we categorize all degrees into eight groups: Education; Humanities and Arts; Social Sciences; Business and Law; Science; Engineering, Manufacturing and Construction; Agriculture; Health and Welfare. Table 8 reports the estimates. Consistent with the previous results, we find that the SISU adoption leads to similar impacts on test scores, migration and enrollment status in almost all fields.

Taken together, Tables 7 and 8 suggest that centralization does not favor specific pro-

[40] A new registration is possible both within SISU (if the students was wait-listed in his first option), or in seats available outside SISU.

[41] We replicate these steps for an alternative combination of the 2013 ENEM microdata with the 2014 Census, as a robustness check. The findings remain similar.

grams. Switching into a centralized admission system would likely create positive impacts for all college degrees and institutions that are able to recruit in a broader market.

6 Conclusion

In recent years, the creation of centralized clearinghouses has become a widespread education policy under the argument that it provides a broader access to all candidates and produces better outcomes (Hoxby, 2003; Abdulkadiroglu et al., 2015; Hatfield et al., 2016). In this paper, we provide some the first empirical evidence on the consequences of centralization in the college market.

To do so, we exploit variation induced by the gradual introduction of a new centralized clearinghouse across higher education institutions between 2010 and 2014 in Brazil, yielding three primary results. First, we find that the adoption of a centralized mechanism largely impacts the quality of incoming students, which is measured by their standardized test scores. This positive effect corresponds to an increase by approximately one third of a standard deviation, which can be interpreted as a result of better student-institution matches. Second, we find that centralization positively affects students' mobility. The likelihood of attending college in a different state is increased by a sizable amount, guaranteeing fair access beyond geography. Third, we find negligible effects of centralization on final enrollment rates, but positive effects on the turnover rate of seats, indicating a higher search intensity by students. Overall, we find positive effects of centralization in the college market.

The setting of our study indicates that these findings can be extended more broadly to any admission or recruiting effort made at a large geographical scale, such as post-graduate admission or even labor market recruiting. Key features in the setting should encompass a unique metric that ranks candidates and the absence of geographical restrictions in the admission process. Our findings also underscore broader questions for further research. College education is an important determinant of returns in the labor market, and future work will investigate the cumulative and long-run effects of college centralization.

References

Abdulkadiroglu, A., N. Agarwal, and P. A. Pathak (2015). The Welfare Effects of Coordinated Assignment: Evidence from the NYC HS Match. *Working Paper 21046, NBER*.

Abdulkadiroglu, A., P. A. Pathak, and A. E. Roth (2005). The New York City High School Match. *American Economic Review*, 364–367.

Agarwal, N. (2015, July). An Empirical Model of the Medical Match. *American Economic Review 105*(7), 1939–78.

Arcidiacono, P., E. M. Aucejo, H. Fang, and K. I. Spenner (2011). Does Affirmative Action Lead to Mismatch? A New Test and Evidence. *Quantitative Economics 2*(3), 303–333.

Arcidiacono, P. and M. Lovenheim (2016). Affirmative Action and the Quality—Fit Trade-Off. *Journal of Economic Literature 54*(1), 3–51.

Assunção, J. and B. Ferman (2011). Does Affirmative Action Enhance or Undercut Investment Incentives? Evidence from Quotas in Brazilian Public Universities. *Manuscript, Massachusetts Institute of Technology Department of Economics*.

Bettinger, E. P., B. T. Long, P. Oreopoulos, and L. Sanbonmatsu (2012). The Role of Application Assistance and Information in College Decisions: Results from the H&R Block Fafsa Experiment. *The Quarterly Journal of Economics 127*(3), 1205–1242.

Black, S. E., K. E. Cortes, and J. A. Lincove (2015). Academic Undermatching of High-Achieving Minority Students: Evidence from Race-Neutral and Holistic Admissions Policies. *The American Economic Review 105*(5), 604–610.

Bordon, P. and C. Fu (2015). College-Major Choice to College-Then-Major Choice. *The Review of Economic Studies 82*(4), 1247–1288.

Camargo, B., R. Camelo, S. Firpo, and V. P. Ponczek (2014). Information, Market Incentives, and Student Performance.

Carrell, S. E. and B. Sacerdote (2013). Why Do College Going Interventions Work? Working Paper 19031, National Bureau of Economic Research.

Chade, H., G. Lewis, and L. Smith (2014). Student Portfolios and the College Admissions Problem. *The Review of Economic Studies 81*(3), 971–1002.

Che, Y.-K. and Y. Koh (2016). Decentralized college admissions. *Journal of Political Economy 124*(5), 1295–1338.

Cohodes, S. R. and J. S. Goodman (2014). Merit Aid, College Quality, and College Completion: Massachusetts' Adams Scholarship as an In-Kind Subsidy. *American Economic Journal: Applied Economics 6*(4), 251–285.

Dillon, E. and J. Smith (2016). Determinants of the Match between Student Ability and College Quality. *Journal of Labor Economics, forthcoming*.

Estevan, F., T. Gall, and L.-P. Morin (2016). Redistribution Without Distortion: Evidence from an Affirmative Action Program at a Large Brazilian University. Technical report, University of São Paulo (FEA-USP).

Fitzpatrick, M. D. and D. Jones (2012). Higher Education, Merit-Based Scholarships and Post-Baccalaureate Migration. Technical report, National Bureau of Economic Research.

Francis, A. M. and M. Tannuri-Pianto (2012). Using Brazil's Racial Continuum to Examine the Short-Term Effects of Affirmative Action in Higher Education. *Journal of Human Resources 47*(3), 754–784.

Fu, C. (2014). Equilibrium Tuition, Applications, Admissions, and Enrollment in the College Market. *Journal of Political Economy 122*(2), 225–281.

Gale, D. and L. S. Shapley (1962). College Admissions and the Stability of Marriage. *American mathematical monthly*, 9–15.

Gneezy, U., M. Niederle, A. Rustichini, et al. (2003). Performance in Competitive Environments: Gender Differences. *The Quarterly Journal of Economics- 118*(3), 1049–1074.

Griffith, A. L. and D. S. Rothstein (2009). Can't get there from here: The decision to apply to a selective college. *Economics of Education Review 28*(5), 620–628.

Groen, J. A. (2004). The Effect of College Location on Migration of College-Educated Labor. *Journal of Econometrics 121*(1), 125–142.

Guellec, D. and M. Cervantes (2002). International Mobility of Highly Skilled Workers: From Statistical Analysis to Policy Formulation. *International mobility of the highly skilled*, 71–98.

Hafalir, I. E., R. Hakimov, D. Kübler, and M. Kurino (2014). College Admissions with Entrance Exams: Centralized versus Decentralized. *No. SP II 2014-208. WZB Discussion Paper*.

Hastings, J. S., C. A. Neilson, and S. D. Zimmerman (2013). Are Some Degrees Worth More Than Others? Evidence from College Admission Cutoffs in Chile. Technical report, National Bureau of Economic Research.

Hatfield, J. W., F. Kojima, and Y. Narita (2016). Improving Schools through School Choice: A Market Design Approach. *Journal of Economic Theory*.

Hoper Educação (2014). Análise Setorial do Ensino Superior Privado – Brasil 2014. *Hoper Estudos de Mercado*.

Hoxby, C. and C. Avery (2014). The Missing "One-Offs": The Hidden Supply of High-Achieving, Low-Income Students. *Brookings Papers on Economic Activity*.

Hoxby, C. and S. Turner (2013). Expanding College Opportunities for High-Achieving, Low Income Students. *Stanford Institute for Economic Policy Research Discussion Paper* (12-014).

Hoxby, C. M. (2003). School Choice and School Productivity. Could School Choice Be a Tide that Lifts all Boats? In *The economics of school choice*, pp. 287–342. University of Chicago Press.

Hoxby, C. M. and S. Turner (2015, May). What high-achieving low-income students know about college. *American Economic Review 105*(5), 514–17.

Niederle, M. and A. E. Roth (2003). Unraveling Reduces Mobility in a Labor Market: Gastroenterology With and Without a Centralized Match. *Journal of political Economy 111*(6), 1342–1352.

Niederle, M. and L. Vesterlund (2007). Do Women Shy Away From Competition? Do Men Compete Too Much? *The Quarterly Journal of Economics 122*(3).

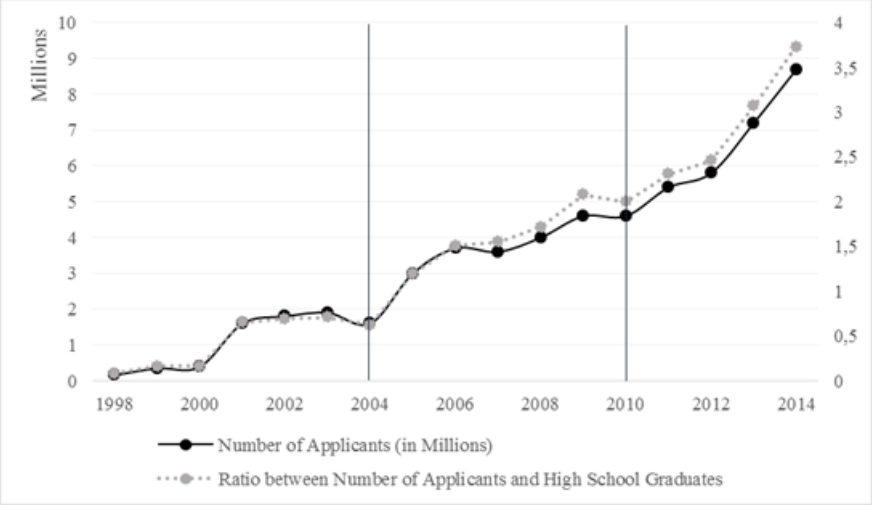
Pallais, A. (2015). Small Differences that Matter: Mistakes in Applying to College. *Journal of Labor Economics 33*, 493–520.

Roth, A. E. and X. Xing (1997). Turnaround time and bottlenecks in market clearing: Decentralized matching in the market for clinical psychologists. *Journal of Political Economy 105*(2), 284–329.

Sander, R. H. and S. Taylor (2012). *Mismatch: How Affirmative Action Hurts Students It's Intended to Help, and Why Universities Won't Admit It*. Basic Books.

Szerman, C. (2015). The Effects of a Centralized College Admission Mechanism on Migration and College Enrollment: Evidence from Brazil. *http://bibliotecadigital.fgv.br/dspace/handle/10438/13875*.

Figure 1: Evolution of ENEM



Note: Graph shows, on the left axis, how the number of ENEM applicants rapidly evolved, since its first edition. On the right axis, graph shows the ratio of total number of applicants divided by the number of high school graduates. Information on applicants are obtained from ENEM microdata. Information on high school graduates are obtained from the annual School Census. The first edition, in 1998, received 157.221 registrations (approximately 0.1% of the Brazilian population), while the last edition received 8.721.946 registrations (roughly 4.3% of the Brazilian population), in 2014.

Table 1: Descriptive Statistics, Census-ENEM Matched Sample

Variables	2010	2011	2012	2013	2014
standardized ENEM scores	1.14	1.14	1.15	1.16	1.27
	(0.97)	(0.92)	(0.96)	(0.99)	(1.04)
% migration(municipality)	0.53	0.50	0.50	0.50	0.49
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)
% migration (state)	0.11	0.09	0.09	0.10	0.10
	(0.31)	(0.29)	(0.29)	(0.29)	(0.30)
% inactive	0.12	0.11	0.13	0.13	0.14
	(0.32)	(0.31)	(0.34)	(0.33)	(0.34)
% SISU*	0.23	0.37	0.44	0.51	0.62
	(0.42)	(0.48)	(0.50)	(0.50)	(0.48)
% *vestibular*	0.77	0.67	0.55	0.47	0.39
	(0.42)	(0.47)	(0.50)	(0.50)	(0.49)
% ENEM	0.22	0.28	0.36	0.48	0.51
	(0.47)	(0.48)	(0.50)	(0.50)	(0.50)
% female	0.54	0.52	0.53	0.52	0.51
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)
age	21.05	21.52	21.63	21.74	22.12
	(5.05)	(5.61)	(5.78)	(6.00)	(6.41)
% white	0.20	0.22	0.23	0.23	0.32
	(0.40)	(0.41)	(0.42)	(0.42)	(0.47)
% disabled	0.00	0.00	0.00	0.01	0.01
	(0.06)	(0.06)	(0.07)	(0.07)	(0.09)
% under social support	0.14	0.12	0.13	0.18	0.14
	(0.34)	(0.33)	(0.34)	(0.38)	(0.35)
% admitted through quotas	0.12	0.12	0.15	0.20	0.28
	(0.33)	(0.33)	(0.35)	(0.40)	(0.45)
number of seats	55.74	58.94	57.65	57.78	55.95
	(46.31)	(50.95)	(49.32)	(49.37)	(48.68)
Observations	237.737	293.711	319.868	334.712	352.980

Note: This table reports yearly descriptive statistics for first-year students enrolled in federal and state public institutions over the 2010-2014 period. The sample includes all students who took ENEM exam in the previous year. Table displays means and standard deviations in parenthesis. Sources: Higher Education Census and ENEM microdata.
* - Calculated using the Census baseline sample.

Table 2: 2009 Characteristics of Treated and Untreated Institutions

	Untreated	**Treated**	**p-Value**
Observations	69	109	–
A. Students' Characteristics			
ENADE Scores	0.416	0.584	0.3344
Inactive	0.064	0.079	0.2227
Female	0.516	0.512	0.8579
White	0.229	0.212	0.6650
Disabled	0.009	0.006	0.6182
Admitted through ENEM	0.044	0.050	0.8471
Admitted through *Vestibular*	0.968	0.948	0.2749
Migration (State)	0.146	0.170	0.3136
Migration (Municipality)	0.530	0.525	0.9013
Receive Social Support	0.040	0.059	0.4517
Benefited from Quota System	0.099	0.068	0.2287
Age	24.691	23.820	0.0565
B. Institutions' Characteristics			
University Institutions	0.373	0.615	0.0017
Federal Institutions	0.060	0.826	0.0000
Bachelor's Degree Programs	0.287	0.392	0.0225
Located in State Capital Cities	0.281	0.301	0.7237
Located in Central-West Region	0.031	0.088	0.1285
Located in North Region	0.061	0.123	0.1732
Located in Northeast Region	0.164	0.277	0.0799
Located in Southeast Region	0.569	0.349	0.0036
Located in South Region	0.176	0.163	0.8198
Number of Employees	753.971	917.716	0.5245
Number of Students	1600.403	2570.486	0.0106
Number of Programs	69.725	64.661	0.8445
Number of Teachers	546.609	785.771	0.0810
Institutions Have a Lab	0.780	0.778	0.9514

This table reports comparison of 2009 students' and institutions' characteristics of treated and untreated institutions. Treated institutions are those that adopted the centralized clearinghouse in some point between 2010 and 2014. The p-value comes from the t-test of equality across both groups. Students' characteristics include standardized ENADE scores of first-year students, the share of inactive, female, white and disabled students, the fraction of students admitted through ENEM and *Vestibular* exams, the fraction of students that currently study in a location different from birthplace, the share of students that receive any type of social support, the fraction of students that are benefited from quota system, and the average student age. Inactive students are those whose enrollment status is on leave or cancellation. Sources: Higher Education Census and ENADE microdata.

Table 3: Effects of SISU on Observable Characteristics of Students and Programs

	(1) female	(2) age	(3) white	(4) disabled	(5) admissions though quota	(6) social support	(7) admissions using ENEM	(8) admissions using *vestibular*	(9) number of seats
SISU	-0.022***	0.534***	-0.000	0.000	0.004	-0.000	0.331***	-0.345***	1.694*
	(0.003)	(0.076)	(0.023)	(0.001)	(0.028)	(0.016)	(0.057)	(0.056)	(0.975)
Constant	0.530***	20.922***	0.287***	-0.010***	0.126***	0.121***	0.150***	0.882***	56.784***
	(0.002)	(0.062)	(0.027)	(0.003)	(0.024)	(0.013)	(0.039)	(0.041)	(0.666)
Observations	1,539,008	1,539,008	1,539,008	1,539,008	1,539,008	1,539,008	1,539,008	1,539,008	35,420
R-squared	0.174	0.158	0.265	0.011	0.198	0.423	0.682	0.676	0.932
Program FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
State Trend	✓	✓	✓	✓	✓	✓	✓	✓	✓

Note: ***: significant at 1% level; **: significant at 5% level; *: significant at 10% level. This table presents the effects of moving to SISU on students, programs and programs' characteristics, after controlling for year and program fixed effects, as well as state trend. The dependent variables are indicator variables for female students, students' age, indicator variables for white students and disabled students, students that receive social support, students that are benefited from quota system, students admitted through ENEM and *Vestibular*, and total number of seats in each program, respectively. The independent variable SISU is an indicator for whether the program p partially or fully adopted the SISU system in the year t. Robust standard errors clustered at institution level are reported in parenthesis. Sources: Higher Education Census and ENEM microdata.

Table 4: Effect of SISU on ENEM Scores

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
SISU	0.157*	0.324***	0.328***	0.328***	0.300***	0.302***	0.277***
	(0.087)	(0.032)	(0.032)	(0.032)	(0.031)	(0.030)	(0.029)
Constant	1.093***	1.029***	1.226***	1.228***	0.995***	1.193***	1.173***
	(0.080)	(0.019)	(0.027)	(0.032)	(0.021)	(0.030)	(0.029)
Observations	1,539,008	1,539,008	1,539,008	1,539,008	1,539,008	1,539,008	1,346,489
R^2	0.006	0.585	0.601	0.601	0.588	0.604	0.619
Individual Controls			✓	✓		✓	✓
Program Controls				✓		✓	✓
Program FE		✓	✓	✓	✓	✓	✓
Year FE		✓	✓	✓	✓	✓	✓
State Trend					✓	✓	✓
Sample	2010-2014	2010-2014	2010-2014	2010-2014	2010-2014	2010-2014	Enrolled

Note: ***: significant at 1% level; **: significant at 5% level; *: significant at 10% level. This table reports the effects of adopting SISU on standardized ENEM score of first-year students. The sample consists of 1.539.008 students from federal and state public institutions over the 2010-2014 period. Column (1) presents result for a simple OLS regression. Columns (2) displays estimates after controlling for program and year fixed effects, while Column (3) includes a full set of observable student covariates (age, gender, race, disability, indicator for whether the student is benefited from quota system and indicator for whether the student receives social support), and program and year fixed effects. Column (4) includes program covariates (number of seats). Column (5) only considers state trends, program and year fixed effects. Column (6) also includes controls, while Column (7) excludes individuals whose enrollment status is on leave or cancellation from the sample. Robust standard errors clustered at institution level are reported in parenthesis. Sources: Higher Education Census and ENEM microdata.

Table 5: Effect of SISU on Migration

PANEL A	(1) state ENEM	(2) state ENEM	(3) state ENEM	(4) state ENEM	(5) state ENEM	(6) state ENEM
SISU	0.054***	0.058***	0.024***	0.023***	0.025***	0.021***
	(0.013)	(0.013)	(0.005)	(0.005)	(0.005)	(0.005)
Constant	0.068***	0.153***	0.074***	0.066***	0.054***	0.051***
	(0.009)	(0.016)	(0.006)	(0.007)	(0.007)	(0.006)
Observations	1,539,008	1,539,008	1,539,008	1,539,008	1,539,008	1,346,489
R^2	0.008	0.014	0.172	0.172	0.173	0.172
Individual Controls			✓	✓	✓	✓
ENEM Score			✓	✓	✓	✓
Program Controls				✓	✓	✓
Program FE		✓	✓	✓	✓	✓
Year FE		✓	✓	✓	✓	✓
State Trend					✓	✓
Sample	2010-2014	2010-2014	2010-2014	2010-2014	2010-2014	Active

PANEL B	(1) state ENEM	(2) municipality ENEM	(3) state birthplace	(4) municipality birthplace	(5) state birthplace	(6) municipality birthplace
SISU	0.025***	0.014**	0.029**	0.034**	0.031***	0.033***
	(0.005)	(0.005)	(0.011)	(0.016)	(0.010)	(0.016)
Constant	0.054***	0.605***	0.103***	0.550***	0.139***	0.546***
	(0.007)	(0.011)	(0.015)	(0.019)	(0.011)	(0.014)
Observations	1,539,008	1,539,008	1,049,651	1,049,651	1,517,614	1,517,614
R^2	0.173	0.242	0.144	0.275	0.130	0.254
Individual Controls	✓	✓	✓	✓	✓	✓
ENEM Score	✓	✓	✓	✓		
Program Controls	✓	✓	✓	✓	✓	✓
Program FE	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓
State Trend	✓	✓	✓	✓	✓	✓
Sample	2010-2014	2010-2014	2010-2014	2010-2014	2010-2014	2010-2014

Note: ***: significant at 1% level; **: significant at 5% level; *: significant at 10% level. Panel A reports the effects of adopting SISU on inter-state migration of first-year students. The dependent variable is an indicator for whether the state where the student resided before entering college is different from the state where the student attends college. Column (1) presents result for a simple OLS regression. Columns (2) displays estimates after controlling for program and year fixed effects, while Column (3) includes a full set of observable student covariates (age, gender, race, disability, indicator variables for whether the student is benefited from quota system and receives social support), ENEM scores, and program and year fixed effects. Column (4) includes program covariates (number of seats). Column (5) also considers state trend, while Column (6) excludes individuals whose enrollment status is on leave or cancellation from the sample. Panel B reports the effects of adopting SISU on alternative measures for migration of first-year students. In Column (1), the dependent variable is the same as in Panel A. Column (2) presents the result for the dependent variable defined as indicator for whether the municipality where the student resided before entering college differs from the municipality where the student attends college. The dependent variable *municipality birthplace* (*state birthplace*) is an indicator for whether the municipality (state) of birth is different from the municipality (state) where the student attends college. All columns consider a regression with students' characteristics, program covariates (number of seats), program and year fixed effects, and state trends. Columns (1)-(4) additionally control for ENEM scores. Robust standard errors clustered at institution level are reported in parenthesis. Sources: Higher Education Census and ENEM microdata.

Table 6: Effect of SISU on Enrollment Status

	(1) inactive	(2) inactive	(3) on leave	(4) cancellation	(5) on leave	(6) vacancy rate
SISU	0.043***	0.054***	0.008	0.046***	0.011*	0.005
	(0.006)	(0.008)	(0.005)	(0.007)	(0.006)	(0.018)
Constant	0.014	0.068***	-0.021	0.089***	-0.023	-0.119***
	(0.016)	(0.023)	(0.016)	(0.016)	(0.018)	(0.036)
Observations	1,539,008	2,167,313	2,167,313	2,167,313	1,976,952	37,581
R-squared	0.116	0.100	0.071	0.100	0.077	0.481
Individual Controls	✓	✓	✓	✓	✓	
ENEM Score	✓					
Program Controls	✓	✓	✓	✓	✓	✓
Program FE	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓
State Trend	✓	✓	✓	✓	✓	✓

Note: ***: significant at 1% level; **: significant at 5% level; *: significant at 10% level. This table reports the effects of adopting SISU on different dependent variables. In Columns (1) and (2), the dependent variable is an indicator variable for whether student's enrollment status is on leave or cancellation. In Column (3), the dependent variable is a dummy variable for whether student's enrollment status is on leave, while Column (4) refers to cancellation only. Column (5) excludes individuals that requested cancellation and the dependent variable is defined as an indicator for whether student's enrollment status is on leave. Column (6) reports the effects of SISU on the 1 minus the ratio between the number of enrolled students by the end of first year and the number of seats. In all specifications, program covariates (number of seats), program and year fixed effects, and state trends are included. We include ENEM scores in Column (1). We also add students' characteristics in Columns (1) - (5). Robust standard errors clustered at institution level are reported in parenthesis. Sources: Higher Education Census and ENEM microdata.

Table 7: Heterogeneity by 2009 ENEM Scores

Variables	(1) score	(2) state	(3) inactive	(4) score	(5) state	(6) inactive	(7) score	(8) state	(9) inactive	(10) score	(11) state	(12) inactive
SISU	0.284***	0.027***	0.048***	0.325***	0.020***	0.034***	0.332***	0.014**	0.046***	0.259***	0.035***	0.049***
	(0.039)	(0.006)	(0.013)	(0.039)	(0.005)	(0.009)	(0.039)	(0.006)	(0.007)	(0.034)	(0.011)	(0.010)
Constant	0.188***	0.060***	0.054**	0.691***	0.075***	0.066***	1.234***	0.048***	0.048*	2.126***	0.035**	-0.088***
	(0.023)	(0.007)	(0.022)	(0.049)	(0.010)	(0.017)	(0.039)	(0.008)	(0.026)	(0.040)	(0.015)	(0.015)
Observations	208,618	208,618	208,618	307,897	307,897	307,897	374,711	374,711	374,711	448,840	448,840	448,840
R^2	0.222	0.128	0.127	0.218	0.164	0.122	0.241	0.170	0.107	0.494	0.180	0.094
Individual Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ENEM Score		✓	✓		✓	✓		✓	✓		✓	✓
Program Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Program FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
State Trend	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sample	Bottom quartile	Bottom quartile	Bottom quartile	2nd quartile	2nd quartile	2nd quartile	3rd quartile	3rd quartile	3rd quartile	Top quartile	Top quartile	Top quartile

Note: ***: significant at 1% level; **: significant at 5% level; *: significant at 10% level. We test whether the effects on scores, migration and droout are heterogeneous across different levels of 2009 ENEM scores. Controlling for students' characteristics, number of seats, program and year fixed effects, and state trends, we run regressions separately for four sub-samples of individuals. In Columns (2), (3), (5), (6), (8), (9), (11) and (12), ENEM scores are included in the baseline specification. By year, the sample is broken into quartiles based on the average 2009 ENEM scores of students enrolled in all programs listed in the 2010 Census, with the bottom quartile facing the smallest average scores and the top quartile facing the largest average scores. The dependent variables are the same as in Tables 4, 5 (Panel A), and 6 (Column (1)). Robust standard errors clustered at institution level are reported in parenthesis. Sources: Higher Education Census and ENEM microdata.

Table 8: Heterogeneity by Field of Study

PANEL A	(1) score	(2) state	(3) inactive	(4) score	(5) state	(6) inactive	(7) score	(8) state	(9) inactive	(10) score	(11) state	(12) inactive
SISU	0.319***	0.019***	0.044***	0.341***	0.026***	0.027	0.283***	0.031***	0.043***	0.302***	0.021***	0.063***
	(0.033)	(0.004)	(0.010)	(0.065)	(0.010)	(0.021)	(0.034)	(0.006)	(0.009)	(0.034)	(0.005)	(0.009)
Constant	0.780***	0.060***	0.056**	1.424***	0.042***	0.095***	1.506***	0.050***	-0.019*	1.221***	0.050***	0.024
	(0.032)	(0.006)	(0.022)	(0.050)	(0.010)	(0.029)	(0.044)	(0.011)	(0.011)	(0.038)	(0.014)	(0.043)
Observations	424,318	424,318	424,318	55,103	55,103	55,103	276,474	276,474	276,474	193,924	193,924	193,924
R^2	0.422	0.114	0.137	0.455	0.131	0.104	0.595	0.148	0.098	0.483	0.142	0.107
Individual Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ENEM Score		✓	✓		✓	✓		✓	✓		✓	✓
Program Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Program FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
State Trend	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Field of Study	Education	Education	Education	Humanit. and Arts	Humanit. and Arts	Humanit. and Arts	Soc. Sc., Bus. and Law	Soc. Sc., Bus. and Law	Soc. Sc., Bus. and Law	Science	Science	Science

PANEL B	(1) score	(2) state	(3) inactive	(4) score	(5) state	(6) inactive	(7) score	(8) state	(9) inactive	(10) score	(11) state	(12) inactive
SISU	0.230***	0.026**	0.028***	0.295***	0.034***	0.028*	0.320***	0.029***	0.036***	0.324***	0.022**	0.039**
	(0.031)	(0.011)	(0.009)	(0.039)	(0.011)	(0.014)	(0.042)	(0.010)	(0.010)	(0.055)	(0.008)	(0.019)
Constant	1.604***	0.094***	-0.049***	0.838***	0.107***	-0.006	1.665***	0.068***	-0.055***	0.931***	0.041***	0.045**
	(0.030)	(0.014)	(0.015)	(0.057)	(0.021)	(0.027)	(0.052)	(0.014)	(0.012)	(0.063)	(0.011)	(0.023)
Observations	265,879	265,879	265,879	106,026	106,026	106,026	176,129	176,129	176,129	31,092	31,092	31,092
R^2	0.584	0.186	0.077	0.460	0.167	0.122	0.687	0.223	0.102	0.433	0.085	0.113
Individual Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ENEM Scores		✓	✓		✓	✓		✓	✓		✓	✓
Program Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Program FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
State Trend	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Field of Study	Engin.	Engin.	Engin.	Agriculture	Agriculture	Agriculture	Health and Welfare	Health and Welfare	Health and Welfare	Services	Services	Services

Note: ***: significant at 1% level; **: significant at 5% level; *: significant at 10% level. Controlling for students' characteristics, number of seats, program and year fixed effects, and state trends, we test whether the effects are heterogeneous across different fields of study, following international classification. In Columns (2), (3), (5), (6), (8), (9), (11) and (12), ENEM scores are included in the baseline specification. The dependent variables are the same as in Tables 4, 5 (Panel A), and 6 (Column (1)). Robust standard errors clustered at institution level are reported in parenthesis. Sources: Higher Education Census and ENEM microdata.

7 APPENDIX

7.1 Appendix I

SISU APPLICATION AND ADMISSION

Applicants have to take the ENEM exam to register in the SISU system. Online registration for ENEM typically takes place in May, and the registration fee costs 68 *reais* in 2016 (approximately USD 20). Students from public schools and low-income families are free-exempt.

The new ENEM exam is a two-day test and consists of a written essay and 180 multiple-choice questions, divided into four knowledge areas: Math, Natural Science, Human Science, and Language and Code. In comparison to the older version, the new exam comprises a wider range of subjects: Human Science (Geography, History, Philosophy, and Sociology), Language and Codes (Foreign Language, Literature, and Portuguese), Math (Geometry and Math), and Natural Science (Biology, Chemistry, and Physics). All applicants take ENEM on the same weekend, typically in October or November.

They receive their ENEM scores in January. Few days later, the SISU online platform opens. Applicants subscribe to the system by submitting their ENEM subscription number. There is no monetary cost to subscribe to SISU. All applicants have four (or five, depending on the rules previously set by the Ministry of Education) days to submit a list of up to two options of career-institution (program) pair and decide whether they will compete for seats reserved for quota system.

Students' scores are calculated according to different weights given to each of five knowledge areas (Math, Natural Science, Languages and Codes, Human Science, and Writing Essay). Each institution is free to determine a combination of weights for each program. Thus, students' scores might widely vary across these career-institution combinations.

During the registration period, when the system is open, the cutoff scores for each program are calculated at the end of each day, and this information is provided to all subscribers. The partial classification for each subscriber is also privately disclosed. Students can change their options over the registration period as many times as they wish, but only the last confirmed choice is valid.

Figure 2 illustrates how an applicant can indicate up to two choices of career and institution combinations, and specify whether he prefers to compete for seats reserved for

affirmative action policies. It is possible to notice different composite scores given to the same applicant because he chooses different careers from the same institution. Figure 3 presents the partial classification and the cutoff score for each chosen option. Figure 4 indicates that the system allows an applicant to modify his assignments as many times as he wishes until the deadline. Figure 5 shows that an applicant can search for other majors and institutions, and also check the last updated cutoff.

When the registration period ends, students are assigned to programs through a variant of deferred acceptance algorithm. The algorithm works in the following way: each candidate proposes to his first choice. After ranking the applicants by their composite score, each program rejects the lowest-ranking students in excess of the pre-specified number of available spots, and the remaining applicants are tentatively admitted. The applicants rejected in their first alternative apply to the next most preferred program from their list. Thus, each program considers these new applicants and the tentatively admitted applicants, and assigns its spots to these candidates, following a priority order. The lowest-ranking students in excess of the number of available seats are rejected.

At least one call is announced. The number of calls is previously set up for each edition; for example, in January of 2015, SISU had a single call. During the call period, the applicants who ranked and qualified for their assigned option can enroll in the program. Regardless of having enrolled in his first option, if the applicant is qualified to his top choice, he cannot participate in the next call. Also, regardless of having enrolled in his second alternative, the applicant still runs to his first in the next call when he qualifies for his second choice, but not for his first choice. After regular calls, students who did not qualify for their options should inform to the system if they wish to be included on a wait list. In this case, only the first option is considered. Thereafter, SISU provides to institutions a wait list for each program and the progress is similar to *Vestibular*. Any remaining spot is filled based on a wait list, following the ranking of applicants.

Figure 2: An Example of Choices from the SISU System

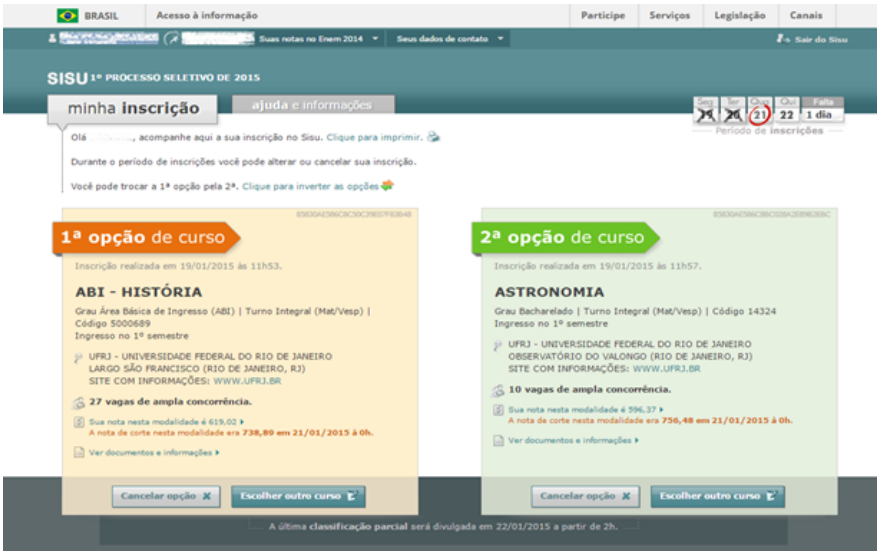


Figure 3: An Example of Partial Classification and Cutoff Scores

Figure 4: An Example of an Applicant Modifying his Options

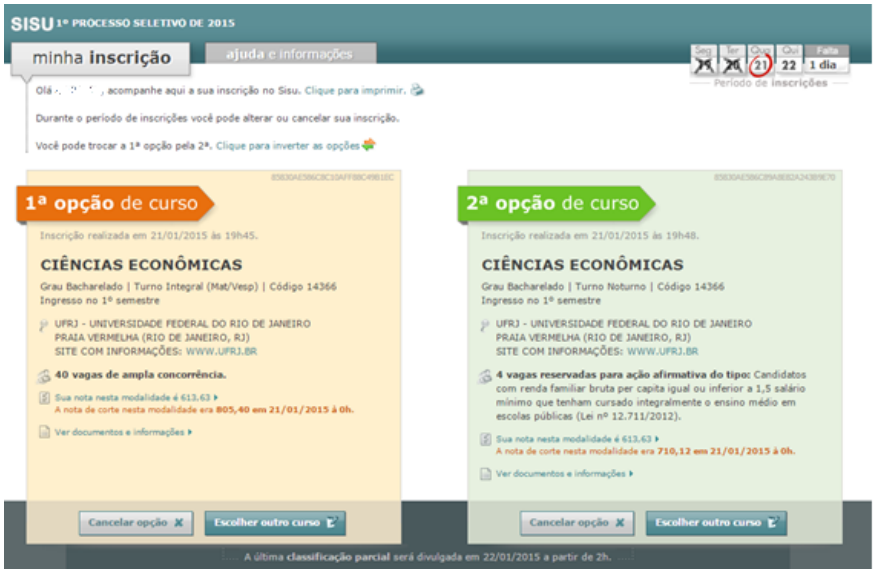
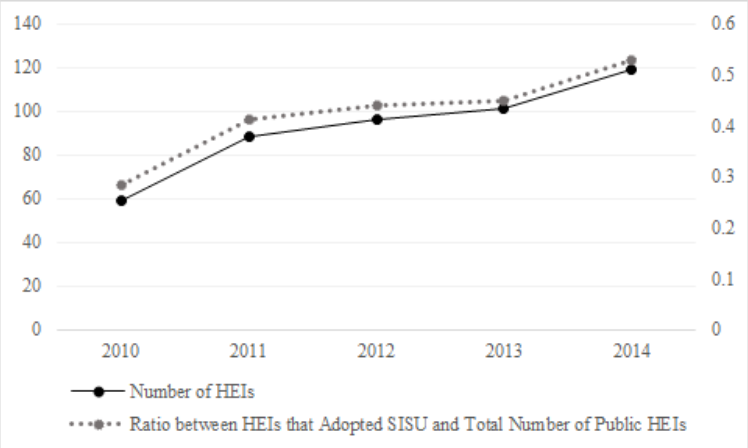


Figure 5: An Example of an Applicant Searching for Other Options and Checking the Last Updated Cutoff

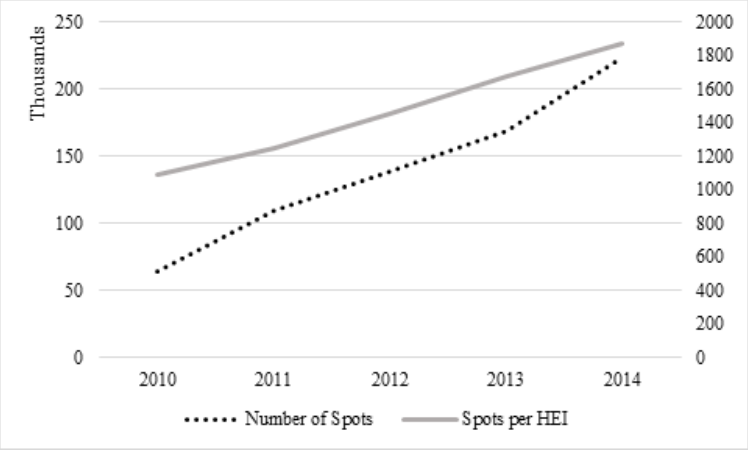
7.2 Appendix II
Evolution of SISU

Figure 6: Evolution of SISU (In Number of Institutions)



Note: the graph illustrates how SISU expanded over time, by showing the annual evolution of the number of institutions that adopted SISU (on the left) and the ratio between the number of institutions that adopted SISU and the total number of federal and state public institutions (on the right). Data on institutions that adopted SISU comes from the Ministry of Education. Number of public institutions between 2010 and 2014 comes from the Higher Education Census. In absolute values, only 59 institutions participated in SISU in the first year, in 2010. In the following years, the number increased to 88 (in 2011), 96 (in 2012), 101 (in 2013) and 119 (in 2014) higher education institutions

Figure 7: Evolution of SISU (In Number of Spots)



Note: the graph refers to the number of spots offered by SISU. Data is from MEC's announcements. The axis on the left refers to the number of available spots for each year, while the axis on the right refers to the ration between the number of spots offered by SISU and the number of institutions that adopt the system. In all, 64.486, 109.461, 139.100, 169.043, and 223.168 spots were offered in 2010, 2011, 2012, 2013, and 2014, respectively.

7.3 Appendix III

DATA APPENDIX

This appendix contains a detailed description of the data used in this paper.

7.4 Higher Education Census

7.4.1 General Information:

The Higher Education Census is annually carried out by the National Institution for Educational Studies and Research (INEP) since 1995. Microdata at the student level is only available from 2009 onwards. Information on each academic year t (which corresponds to a calendar year) is collected in year *t+1*.[42] The Census contains detailed information on all higher institutions, programs and students enrolled at any time over year t. Reporting is compulsory for all institutions by law. Reporting is also a requirement for many initiatives sponsored by the Ministry of Education, such as research grants and fellowships, and, most importantly, for being issued a credential that allows institutions to operate in the educational market.

Unique identification numbers – the Brazilian Taxpayer Registry (*Cadastro de Pessoa Física*, or *CPF*) – are not reported in 2009, thus the 2009 Census cannot be linked to the 2008 ENEM microdata through CPF). INEP staff discouraged us to use information on 2009 Census because it was the first time when student-level data started to be collected. Thus, our sample analysis is restricted to the 2010-2014 Higher Education Census.

7.4.2 The Brazilian Higher Education Structure:

The Brazilian higher education structure is divided into six administrative categories: special[43], for-profit private, non-profit private, federal public, state public, and municipal public institutions.

[42]Data is collected online, through a platform called *Censup*, and reported by the legal representative of the higher education institution. The system opens from February to May. Data checks are performed by INEP when the system closes, and inconsistencies are communicated to institutions, which in turn submit a final round of edits.

[43]Special institution is a category created in 2012 and refers to institutions created by municipal or state law before the promulgation of the Federal Constitution in 1998. Those institutions, however, are not predominantly funded with public resources. Thus, they are not free.

In 2010, there are 2.378 institutions registered in the Census. They are divided into five administrative categories: (i) federal public, with 99 institutions; (ii) state public, with 108 institutions; (iii) municipal public, with 71 institutions; (iv) for-profit private, with 951 institutions; and (v) non-profit private, with 1.149 institutions. Similarly, in 2011, all 2.365 institutions are found in five administrative categories: (i) federal public, with 103 institutions; (ii) state public, with 110 institutions; (iii) municipal public, with 71 institutions; (iv) for-profit private, with 975 institutions; and (v) non-profit private, with 1.106 institutions. In 2012, a new category was included in the Census and 2.416 institutions are divided into: (i) federal public, with 103 institutions; (ii) state public, with 116 institutions; (iii) municipal public, with 65 institutions; (iv) for-profit private, with 989 institutions; (v) non-profit private, with 1.123 institutions; and (vi) special, with 20 institutions. In 2013, 2.391 institutions are subdivided into: (i) federal public, with 106 institutions; (ii) state public, with 119 institutions; (iii) municipal public, with 54 institutions; (iv) for-profit private, with 991 institutions; (v) non-profit private, with 1.099 institutions; and (vi) special, with 22 institutions. Finally, in 2014, 2.368 institutions are classified into one of the following categories: (i) federal public, with 107 institutions; (ii) state public, with 118 institutions; (iii) municipal public, with 49 institutions; (iv) for-profit private, with 998 institutions; (v) non-profit private, with 1.072 institutions; and (vi) special, with 24 institutions.

Overall, between 2010 and 2014, there are 47.587.650 individuals in the Census (8.337.219 in 2010, 8.961.724 in 2011, 9.565.483 in 2012, and 10.793.935 in 2014). These higher education students are split into different categories of institutions: (i) federal public, with 6.688.933 individuals (1.159.627 in 2010, 1.249.778 in 2011, 1.352.632 in 2012, 1.422.513 in 2013, and 1.504.383 in 2014); (ii) state public, with 3.653.453 individuals (698.167 in 2010, 730.024 in 2011, 745.846 in 2012, 735.991 in 2013, and 743.425 in 2014); (iii) municipal public, with 490.849 individuals (128.191 in 2010, 152.405 in 2011, 75.758 in 2012, 72.081 in 2013, and 62.414 in 2014); (iv) for-profit private, with 17.662.086 individuals (2.697.869 in 2010, 3.026.210 in 2011, 3.569.232 in 2012, 3.854.182 in 2013, and 4.514.593 in 2014); (v) non-profit private, with 18.621.331 individuals (3.653.365 in 2010, 3.803.307 in 2011, 3.663.894 in 2012, 3.676.742 in 2013, and 3.824.023 in 2014); (vi) special institutions[44], with 470.998 individuals (158.121 in 2012, 167.780 in 2013, and 145.097 in 2014).

[44]Special institutions are those created by state or municipal government and do not receive public funding (thus, they are not tuition-free).

7.4.3 Sample Restriction:

We make several restrictions to the sample. First, the sample is restricted to first-year students, since we are interested in short-term effects. Second-year and more advanced students that appear in a given institution do not include those who have dropped out in their first year (and therefore are no longer linked to this institution in their second year), but include transfers from other institutions. Eliminating first-year students reduces the sample from 47.587.650 to 13.181.708 observations[45]. Second, we exclude municipal public, non-profit private, for-profit private, and special institutions from the sample because only public and tuition-free can participate in SISU. Thus, data from federal and state public institutions are maintained. The sample shrinks from 13.181.708 to 2.473.382 observations[46]. Third, we exclude online education programs. This leaves us with a sample of 2.167.313 students[47].

7.4.4 Variable Construction:

Student-level information include (the variables are represented in **bold**):

Gender, Age and Disability. These variables are directly constructed from the Census (the original names are: IN_SEXO_ALUNO, NU_IDADE_ALUNO, and IN_ALUNO_DEFICIENCIA) to inform whether the is **female**, student's **age**, and whether the student has any type of **disability**, respectively.

Socioeconomic Status. Affirmative action policies are directed to students from low income families, from certain ethnic groups, from public schools, and disabled students. We identify students benefiting from the **quota** policy if they occupy seats reserved for low income students (the original variable is IN_RESERVA_RENDA_FAMILIAR), black, mulattos, or Indian students (IN_RESERVA_ETNICO), disabled students (IN_RESERVA_DEFICIENCIA), and/or students who have attended public schools (IN_RESERVA_EN

[45] More precisely, 2.196.822 in 2010, 2.359.409 in 2011, 2.756.773 in 2012, 2.749.803 in 2013, and 3.118.901 in 2014.

[46] Among these observations, 1.619.449 individuals belongs to federal public institutions (302.380 in 2010, 308.537 in 2011, 334.246 in 2012, 325.294 in 2013, and 348.992 in 2014), while 733.852 students are part of state public institutions (141.413 in 2010, 146.170 in 2011, 152.724 in 2012, 142.962 in 2013, and 150.583 in 2014).

[47] Among these observations, 1.464.531 individuals belongs to federal public institutions (269.237 in 2010, 282.040 in 2011, 300.487 in 2012, 299.230 in 2013, and 313.537 in 2014), while 702.782 students are part of state public institutions (134.932 in 2010, 139.111 in 2011, 144.932 in 2012, 139.744 in 2013, and 144.063 in 2014).

In addition, we build a measure of whether the student receives any type of **social support** (e.g., housing support, food support, material support, etc.) from the institution (IN_APOIO_SOCIAL). We also create an indicator variable for whether the student is **white** (CO_COR_RACA_ALUNO) to summarize information on race.

Enrollment Status. Students' enrollment status in a current year, which is summarized by the original variable CO_SITUACAO, falls into one of six categories: currently enrolled (*cursando*), on leave of absence (*matrícula trancada*), withdrawal/cancellation (*desvinculado do curso*), transferred to a new degree in the same institution (*transferido para outro curso da mesma IES*), graduated (*formado*), or deceased (*falecido*). To capture **changes in enrollment status** in the first year of college after initial matriculation, we create an indicator variable of whether the student requests leave of absence or cancellation. This variable does not consider transfer to a new degree in the same institution because transfers are not allowed to first-year students. Also, there are no degrees that last one year, thus graduated students are not expected in our sample of first-year students. Students whose enrollment status is not neither leave of absence nor withdrawal compose the group of **active** students.

Admission Procedure. The Census provides information on entrance procedures for each student: admission through ENEM (the original variable is IN_ING_ENEM), admission through *Vestibular* (the original variable is IN_ING_Vestibular) or other admission systems. In section X, we define the fraction of first-year students admitted through ENEM (**enem**) as the number of first-year students admitted through ENEM divided by the total number of first-year students for each combination of program p and year t. The fraction of first-year students admitted through *Vestibular* is similarly constructed.

Migration. In the next section, we describe how we construct the main measure of mobility. Before that, we explain how we construct an alternative measure for migration to check the robustness of our results: an indicator variable of whether the student's birthplace is different from his current location. Information on students' current location come from program-level data, whereas information on students' birthplace are recovered from student-level data. We then define the interstate (or intermunicipality) mobility as an indicator variable of whether the state (or municipality) of birth is different from the state (or municipality) where the student attended college (namely, **municipality** (or **state**). Because students' birthplace is directly informed by institutions, many observations present

missing information. Nearly 70% of students (more precisely, 1.517.614 out of 2.167.313 observations) have information on place of birth.

Regarding the program (institution) covariates, the following variables are constructed:

Number of Spots. This variable is directly reported by institutions and is available at the program-level data. When no spots are incorrectly reported, we consider the total number of first-year students as a proxy for the number of spots.

Number of Programs. The total number of programs for each institution is constructed from the program-level data.

Number of Instructors. The total number of instructors for each institution is directly built from the faculty-level data. We only consider active, as well partial or full-time instructors.

We explain how we construct the minor variables from Table 2:

Location. Institution-level data provide information on where the institution is located. In Table X, we create an indicator variable (**located in state capital cities**) of whether an institution is based on a state capital city (the original variable is IN_CAPITAL). We also construct indicator variables for each region where an institution is located. Brazil is divided into five regions, thus five indicator variables are created (**located in Central-West region**, **located in North region**, *located in Northeast region*, **located in Southeast region**, and **located in South region**).

Size. We include measures for institutions' size. The total number of technical-administrative employees (**number of employess**) is directly collected from the Census (the original variable is QT_TEC_TOTAL). The total **number of programs**, **number of students** and **number of teachers** are computed from the program-, student- and teacher-level data, respectively.

Other characteristics. Creating an indicator variable for **federal** institutions is straightforward (the original variable is CO_CATEGORIA_ADMINISTRATIVA). We further construct an indicator variable (**university institutions**) of whether an institution is a university organization (CO_ORGANIZACAO_ACADEMICA), as well as an indicator variable (**institutions have a lab**) of whether an institution is equipped with a lab (IN_UTILIZA_LABORATORI

7.5 ENEM Microdata

The ENEM microdata is also annually gathered by INEP. Reporting the Brazilian Taxpayer Registry (CPF) is mandatory to register and take the ENEM exam. In this project, we use confidential data with information on CPF to link ENEM microdata to Higher Education Census. To our knowledge, we are the first researchers have access to these confidential sources.

Firstly, we standardize ENEM scores, which are the average of five areas of knowledge (Natural Science, Math, Human Science, Languages and Codes, and Writing Essay) for all ENEM test-takers by year.

Using CPF as the unique student identification number, we then link five cohorts of first-year students from the Census to the ENEM microdata. That is, the 2010 Census is matched to the 2009 ENEM data (58.82% of the first-year sample[48] is matched), the 2011 Census to the 2010 ENEM data (69.74%[49]), the 2012 Census to the 2011 ENEM data (71.81%[50]), the 2013 Census to the 2012 ENEM data (76.25%[51]), the 2014 Census to the 2013 ENEM data (77.14%[52]). Overall, we are able to combine approximately 71% of college first-year to ENEM datasets (1.539.008 out of 2.167.313 students). We refer these individuals as the **matched sample**.

Our main variable for mobility is constructed from this matched sample. We define the interstate (or intermunicipality) mobility as an indicator variable of whether the state (or municipality) where the student resided when he took the ENEM exam is different from the state (or municipality) where the student attended college (namely, **municipality** (or **state**). Because students' birthplace is directly informed by institutions, many observations present missing information. Nearly 70% of students (more precisely, 1.517.614 out of 2.167.313 observations) have information on place of birth.

We notice a relatively lower matching for the 2010 Census. It can be explained by the episode of leaked questions, which led to the postponement of the exam. Instead of taking place in November of 2010, the exam was rescheduled to be held on December of 2010. Thus, the absence rate from this edition was much higher than the average of previous years.

[48] To be precise, we find exactly 237.737 out of 404.169 individuals.
[49] Out of 421.151 students, we find 293.711 in the ENEM microdata.
[50] Out of 445.419 students, we find 319.868 in the ENEM microdata.
[51] Out of 438.974 students, we find 334.712 in the ENEM microdata.
[52] Out of 457.600 students, we find 352.980 in the ENEM microdata.

Our minor data source is a list of programs and institutions available in the SISU system since its inception. Years of adoption are also included in the list[53], which was provided by the Ministry of Education. We manually coded all programs and institutions to combine them with the Census.

[53] Although the system opens twice a year, the Census data is annual. To deal with this inconsistency, we group the SISU adoption by year.

7.6 Appendix IV
Additional Tables

Table 9: Effect of SISU on Other Observable Characteristics of Students

	(1) mother's educ HS	(2) father's educ HS	(3) mother's educ college	(4) father's educ college	(5) parents' educ college	(6) minimum wage	(7) not urban	(8) elem. sch. more 9 yrs	(9) high sch. more 4 yrs	(10) public elem sch	(11) public high sch
SISU	0.003	0.001	-0.004	-0.004	-0.004	-0.008*	-0.007***	-0.002	-0.006	0.005	0.014
	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.004)	(0.002)	(0.003)	(0.004)	(0.010)	(0.013)
Constant	0.024***	0.154***	0.579***	0.453***	0.342***	0.158***	0.139***	0.036***	0.226***	0.337***	0.450***
	(0.008)	(0.009)	(0.009)	(0.011)	(0.010)	(0.009)	(0.005)	(0.007)	(0.009)	(0.014)	(0.016)
Observations	1,518,263	1,518,263	1,518,263	1,518,263	1,518,263	1,518,263	1,518,263	1,518,263	1,518,263	1,518,263	1,518,263
R-squared	0.095	0.133	0.159	0.189	0.150	0.193	0.088	0.086	0.058	0.338	0.359
Individual Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ENEM Score	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Program Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Program FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
State Trend	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Note: ***: significant at 1% level; **: significant at 5% level; *: significant at 10% level. In this Table, we estimate Equation (1) for additional students' characteristics. The dependent varibles are: *mother's educ HS* is an indicator variable of whether mother's education is less or equal to high school; *father's educ HS* is an indicator variable of whether father's education is less or equal to high school; *mother's educ college* is an indicator variable of whether mother's education is college; *father's educ college* is an indicator variable for whether father's education is college; *parents' educ college* is an indicator variable for whether both parents have college education; *minimum wage* is an indicator for whether family income is less than minimum wage; *not urban* is an indicator for whether the student does not live in an urban area; *elem. sch. more than 9 yrs* is an indicator for whether the student took more than 9 years to finish elementary and middle school; *high sch. more than 4 yrs* is an indicator for whether the student took more than 4 years to finish high school; *public elem sch* is an indicator for whether the student took his elementary and middle education only in a public school; *public high sch* is an indicator for whether the student finished high school in a public school. Robust standard errors clustered at institution level are reported in parenthesis.