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Estimating the Effect of Attending a Public versus a Private University in Colombia on Academic Achievement

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Una Estimación del Efecto sobre el Rendimiento Académico de Asistir a una Universidad Pública o privada en Colombia ♣

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Resumen

Se evalúa el impacto de asistir a una universidad pública sobre el rendimiento académico de los egresados de la educación superior en Colombia. El rendimiento académico se define como el progreso entre el examen de entrada a la universidad y los resultados de las pruebas estandarizadas justo antes de la graduación. Se encuentra que los programas de Instituciones de Educación Superior (IES) públicas mejoran los resultados de los estudiantes en 11 de los 12 programas analizados. La mayoría de los resultados son robustos una vez la muestra se condiciona a programas de mayor calidad (por ejemplo, programas acreditados o las mejores universidades del país). La superioridad de las IES públicas en relación con las privadas sugiere la necesidad de promover una mayor regulación de estas últimas y una revisión de sus estándares actuales para ayudar a superar la brecha existente en términos de valor agregado de las IES públicas en comparación con las privadas. También sugiere que, al menos en el corto plazo, podría ser socialmente beneficioso ampliar la provisión pública en algunos de los programas públicos de educación superior que agregaban más valor.

Palabras Claves: Educación superior pública y privada, Finanzas públicas en educación, estimador de Diferencias en Diferencias, estimador *matching*.

Códigos JEL: A22, I2, J3, D3, O3

♣ We would like to express our appreciation for the helpful comments of participants at the Economics Seminar of *Banco de la Republica* (Central Bank) of Colombia in Bogota, at the workshop for the Regional Study on Higher Education in Latin America and the Caribbean in the World Bank, and in particular, those of Maria Paula Gerardino and Maria Marta Ferreyra. We also thank Daniel Velez, Andrea Franco and Gabriel Suárez for their helpful comments. We also appreciate the access to data provided by ICFES. The works published are provisional, and their authors are fully responsible for the opinions expressed in them, as well as for possible mistakes. The contents of the works published do not compromise *Banco de la República* or its Board of Directors.

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[†] Deceased August 28, 2016.

Estimating the Effect of Attending a Public versus a Private University in Colombia on Academic Achievement[♣]

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Abstract

We evaluate the impacts of attending a public university in Colombia on the academic achievement of graduates from higher education. Our measurement of academic achievement represents the progress made between the college entrance and graduation standardized test scores. We find that public Higher Education Institutions (HEI) improve student test scores in 11 of the 12 programs analyzed. The superiority of public HEIs relative to private ones suggests the need to promote greater regulation of the latter, and a review their current standards to help bridge the gap that currently exists in terms of the value added public HEIs have in comparison to the private ones. It also suggests that, at least in the short run, it could be socially beneficial to expand the public provision of some of the higher education public programs that added more value.

Key words: Public and private higher education, educational finance, differences in differences, matching estimators.

JEL Codes: A22, I2, J3, D3, O3

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I. Introduction

For a developing economy like the Colombian one, which has higher education enrollment rates that reflect its level of development, its challenges lie in continuing to increase its enrollment rates with equity while focusing its efforts on improving quality. These objectives are essential to improving efficiency in allocating labor in the economy and the productivity of that labor, preparing the population to take advantage of technological innovations, creating new markets, and developing a much more formal and equitable labor market.

Higher education enrollment rates in Colombia grew significantly in the 1984-2006 period. Since 1996, in particular, a major change has occurred in the distribution of workers across the different educational levels. The share in this distribution has grown substantially for those with postsecondary education (See Lopez, 2010). By 2012, total expenditure on tertiary education in Colombia as a percentage of GDP was 2%, higher than Germany, 1.4%, and France, 1.5%, although still lower than the United States and South Korea, 2.7% (OECD, 2015).

Even though the total expenditure on higher education in Colombia as a percentage of GDP was not very different from that of these developed economies, the share of total expenditure coming from the public sector is smaller than in all countries but South Korea. While the percentage of expenditure on tertiary education paid for with public funds is 45% in Colombia, it is 55% in the United States, 83% in France, 96% in Germany but only 34% in South Korea (OECD, 2015). Differences in the share of publicly provided tertiary education as well as their respective institutional differences might contribute to explaining the differences in educational achievement between Colombia and these countries.

Privately provided higher education can contribute to improving the quality of higher education on several of the desired dimensions outlined by Barr (2009). First, it can increase competition, and thus generate better incentives for universities to react to what students and firms require. According to the international literature, policies that correctly align incentives for schools have a greater probability of providing high quality education than those focused on expanding their resources, a framework largely valid in the case of universities (Hanushek, 2003). Secondly, private higher education also serves those students who are able to bear the cost of education and expect to be compensated for their investment by the market afterwards. Furthermore, the existence of private options reduces the chance they will compete with students with limited resources at public universities.

In the case of the United States, Eide et al. (1998) found that graduates from elite private undergraduate colleges are more likely to attend a graduate school than graduates either from lower quality private undergraduate colleges, or from public colleges of any quality.

Furthermore, Brewer et al. (1999) found that annual earnings are consistently higher for graduates from private undergraduate colleges than they are for graduates from any public college regardless of its level of quality. In addition, Black et al. (2005) provided evidence that, regardless of whether the universities were public or private, increases in college quality pass a simple social cost-benefit analysis.

Providing high quality tertiary education requires supervising and regulating both public and private universities. Lack of regulation and adequate incentives, regardless of whether there is an increase in higher education enrollment rates, is likely to lead to much lower quality education (See Rau et al., 2013).

The debate about the lack of quality higher education in Colombia, its broad heterogeneity in some academic programs fields, and barriers to access for certain segments of the population has been extensive and has generated several studies, discussions and protests by students, teachers, and other stakeholders.[1] A key point of contention in this debate is the difference in the quality of education provided by public versus private institutions and the differences in the subsequent results they generate in the labor market. These results provide further evidence of the differences in the quality of secondary education provided by public and private institutions, previously documented for Colombia by Guarín, Medina and Posso (2016), and also to the public funding of education in private institutions, previously documented by Bettinger et al. (2016), Angrist et al. (2002), Angrist, Bettinger, Kremer (2006) and Bettinger, Kremer and Saavedra (2010) in the case of secondary education, and by Attanasio et al. (forthcoming), Attanasio, Kugler and Meguir (2011), and Kugler et al. (2015) in the case of job training programs.

This document is part of recent literature that estimates the value added that higher education gives academic performance in Colombia in different contexts.[2] We estimate the differential effect of studying at a public university versus a private one on the value added. Given the endogenous character of attending a public or private university, we require an identification strategy that recognizes this selection issue. Like Balcazar and Ñopo (2014), who studied the effect of enrolling in one education program rather than another, this study obtains matching estimates to identify the causal relationship between the type of school and the value added to academic performance.

[1] See studies such as World Bank (2003), OECD and World Bank (2012), Saavedra and Medina (2012), etc. An example of public statements on the issue was registered with the discussions and marches were held in Colombia in the months of October and November 2011 regarding the amendment to Law 30 of 1992 proposed by the government.

[2] See Saavedra and Saavedra (2011), Melguizo, Zamarro, Velasco and Sanchez (2015), and Gomez (2015) etc.

Our academic achievement measure measures student's progress from the time he or she started college, as measured by the score on the ICFES test or SABER 11, to the time of graduation, measured by the score on the ECAES test or SABER Pro.[3] Given the limited comparability between the subjects evaluated in the ECAES tests within the different programs, the analysis in this document is done at the university program level. This effect can be understood as a proxy for the value added generated by higher education, in particular, the existing differences between the generated value in public and private institutions.

To calculate the differential effect on academic achievement of studying at a public or a private higher educational institution (HEI), differences in differences (DID) matching estimators are obtained using the method proposed by Abadie and Imbens (2006, 2011). We match the ECAES and ICFES test results of students that took the ICFES tests between 2000 and 2004, and the ECAES tests between 2004 and 2008.

We found that the value added of public universities is positive and significant for both men and women in 11 of the 12 programs tested. The positive effects of public universities on engineering programs are robust to analysis within different samples based on different criteria for quality (those at accredited universities, in selective programs which received students with good ICFES test scores, or the ones that have been internationally well-ranked) for both men and women. It is important to notice that in the case of men, much of the effect in engineering, despite being positive, disappears once the sample is restricted to selective programs. However, we find positive and robust effects for both men and women in education, accounting, and dentistry programs. Most of the results obtained in the case of public higher educational institutions are maintained when attendance at a private university is the treatment of interest.

The overwhelming superiority of the public versus private HEI, suggests the need for greater regulation over the latter, to review its current standards, and possibly, of the accredited status that some of these institutions hold so as to help bridge the gap that currently exists in terms of the value added of the public versus private HEI.

The article contains seven sections including this introduction. In the second section, the factors that may differentiate public and private institutions of higher education are discussed. These are the possible mechanisms by which universities could affect academic performance. In the third section, the construction of our data set is described and the main descriptive statistics are provided. Subsequently, some stylized facts about the Colombian labor

[3] Throughout this document, the term ECAES or Saber Pro is used to represent the test taken by university students as the final step their academic program.

market and system of higher education are shown the fourth section. In the fifth section, the econometric methodology used to estimate the effect of public/private higher education on academic achievement is presented. The main results of our exercise are described in the sixth section. The main findings and conclusions are highlighted in the last section.

II. Background and Mechanisms by which the public or private nature of the university affects academic performance

a. Background

Several studies of the Colombian labor market show evidence of significantly better performance in productivity by the skilled versus the unskilled labor force. The skilled have more access to well-paid, quality employment, which may be a reflection of different factors such as technical change, labor market polarization, or effects associated with the quality of higher education, etc.[4]

There are some studies that show that public and private universities generate different results in society, although the evidence for Colombia and Latin America is scarce. Looking across countries Glomm and Ravikumar (1992) studied the effect of human capital accumulation financed through public and private institutions on the evolution of income inequality. The authors found that although public education quickly reduces income inequality, private education generates higher per capita income. Winkler (1995) found that, in the case of Latin America, the public university budget was insufficient during the 80's and 90's and that these institutions used to pay teachers low salaries, which ended up generating negative incentives for research quality. He suggested improving the efficiency of the system by allocating the higher education budget based on performance criteria.

More recently, Del Bello (2002) has shown that the growth of private universities in Latin America has been significant[5], although that growth has taken place at the cost of lower quality. That reduction in quality has been partially due to a poor institutional approach which does not allow appropriate regulation and supervision mechanisms to be generated. According to Del Bello (2002) private university growth has been concentrated in countries like Brazil,

[4] The effects of technical change in the case of Colombia have been studied by Arango, Posada and Uribe (2004), Attanasio, Goldberg and Pavcnik (2003), Cárdenas and Bernal (1999, 2003), Cárdenas and Londoño (1990), Núñez and Sánchez (1998), and Santamaría (2004) etc.; the polarization of the labor market by Medina and Posso (2010).

[5] Jaramillo (2003) presents evidence along the same lines.

Mexico and Colombia. In the case of Chile, Bellei (2007) evaluated the educational reforms through the academic achievements of public and private universities. The author finds that, in general, there were no differences between public and sponsored private universities, and where there are differences, they favor the public university. Moreover, Bellei (2007) argued that, in Chile, those reforms had increased segregation and inequality in education while there was no evidence of overall improvement in the educational system.

Finally, referring to the case of Colombia, Rodriguez and Ramos (2014) found that the private institutions in the Caribbean region of Colombia had significantly lower academic achievement with respect to the public universities in 2009, a fact which is particularly important for law, medical, and engineering programs. Even though they include an aggregate value concept, their framework and empirical application are very different from the ones we will consider next.

In the literature where the value added of higher education in academic performance in Colombia is estimated, Saavedra and Saavedra (2011) studied the value added of higher education on critical thinking, and on skills to solve problems and communicate, by comparing the results on cohort standardized tests of students in their first and last year at the university. Melguizo et al. (2015) estimated the effect of the combination of programs and universities chosen by students on the value added of higher education. Gomez (2015) estimated the value added of higher education on academic performance for different regions of the country. These researchers used standard value added models like those used by McCaffrey et al. (2004), Kane and Staiger (2008), Rivkin et al. (2005), Chetty et al. (2014, 2014b), Cunha and Miller (2014), etc.

In a recent article, Riehl, Saavedra and Urquiola (2016) explore the effect on the academic achievement and earnings of studying at a public or private HEI. Similar to this document, their measure of value added is each student's percentile relative to all other students in their sample in the same exam field and cohort. According to the authors, colleges' value added on earnings and on academic performance are not perfectly correlated, with private HEI adding more value on earnings and the public ones on academic achievement. The authors nonetheless, do not attempt to identify a causal relationship that would allow them to determine whether a specific individual would do better by enrolling in a public versus a private HEI.[6]

[6] Here we provide a clear identification strategy (see section III). There are also significantly differences between theirs and our sample. While Riehl, Saavedra and Urquiola (2016) study a sample with approximately 81,000 graduates from 157 colleges, here we study 129,387 students from 201 HEI, and 14 academic programs. These differences are partly explained by their interest in focusing on graduated students, with earnings observed in their graduation year. In addition, they study the period 2009-2011

b. Mechanisms

The mechanisms by which public or private universities may affect academic achievement are primarily concentrated in three main areas. First, there are differences associated with endowments to institutions of public and private education such as course materials, infrastructure, and teacher quality, etc., which are important for their performance. Second, there is the institutional approach, which provides different incentives for teachers and administrators of public and private educational institutions. Third, there is the role played by classmates in public and private educational institutions. In short, the social environment of the two is very different and this can have an important influence on the students' academic performance.

Among the differences in the types of input used by public and private institutions, one of the most significant ones is related to the quality of their teachersand the effect this has on a student's performance. Hanushek (2002) suggests that teachers with better academic performance and better standardized tests perform better in the classroom. Rivkin et al. (2005) showed that a low-income student can achieve academic results that are comparable to those of a high-income student, if she or he has a teacher whose quality is above average. Hanushek (1992) showed that a student with a "good" teacher could have an academic performance equivalent to a student who is one academic year ahead but has a "bad" teacher.

However, evidence of the effect of public and private university endowments on academic performance in Colombia is limited. Figures from the National Information System of Higher Education (SNIES)[7] of the Ministry of Education show that, for the 2007-2012 period, teachers at public universities are better prepared and have greater dedication on average than teachers at private universities.[8] For example, 37.7% of public university teachers have masters, doctoral or post-doctoral degrees while in the private university, only 32.1% have such degrees. Thus the ratio of students per teacher with doctor's or master's degree in public universities between 2007 and 2012 was 27.3 while in private universities, it was 31.9. Likewise, 37.6% of the teachers in public universities worked full time while in the private

because the ECAES exam was voluntary prior to 2009, and, according to them, in that way they limit selection into taking the exam. Nonetheless, we expect self-selection to be minor since 92% of student who graduated from college between 2004 and 2008 took the ECAES.

[7] SNIES is the acronym in Spanish for *Sistema Nacional de Información de la Educación Superior*.

[8] Since our empirical exercise focuses exclusively on universities, the figures presented in this section focus only on universities while excluding university institutions, technical and technological institutes.

universities, only 29.7% of the teachers did. Interestingly, for the 2007-2012 period, 54.1% of the teachers were part-time employees in both public and private universities (see Table 1).[9]

Table 1. Characteristics of Teachers in public and private universities

	Public		Private	
	Number	Percentage	Number	Percentage
Teachers' education level				
Postdoc	32	0.09%	73	0.18%
Doctorate	2973	8.6%	2087	5.2%
Master	10057	29.0%	10674	26.7%
Specialization	11259	32.5%	13806	34.5%
Bachelor	9856	28.5%	12347	30.9%
Other	463	1.34%	1024	2.56%
Total	**34639**	**100%**	**40010**	**100%**
Teachers' dedication				
Full-Time	13012	37.6%	11864	29.7%
Mid-Time	2065	6.0%	4680	11.7%
Part-Time	836	2.4%	1803	4.5%
Lecturer	18727	54.1%	21659	54.1%
No Information	0	0.00%	4	0.01%
Total	**34639**	**100%**	**40010**	**100%**
Teachers' gender				
Women	12306	35.5%	13581	33.9%
Men	22334	64.5%	26428	66.1%
Total	**34639**	**100%**	**40010**	**100%**
Teachers' Citizenship				
Foreign	311	0.90%	555	1.39%
Domestic	34328	99.1%	39455	98.6%
Total	**34639**	**100%**	**40010**	**100%**

Note: The primary sources of the National Information System of Higher Education (SNIES) were used for the construction of the table. The table includes the average for the period from the first half of 2007 to the second half of 2012. The data are restricted exclusively to institutions with an "academic character" equal to a university. This means technical and technology institutions are excluded.

[9] In the 2007-2012 period, the proportion of teachers by gender is similar in public and private universities. In public universities only 35.5% of teachers are women while in private universities, the ratio is 33.9%. Also, the proportion of foreign teachers is 0.9% at public universities and 1.4% at private universities.

In addition, the academic programs at public universities have (on average) greater recognition in terms of quality than private universities.[10] According to the National Accreditation Committee (CNA),[11] a university or high quality program in Colombia must focus its work "*towards an ideal of excellence*" and must be able to "*show high quality by specific results, consolidated tradition, impact and social recognition*." Currently, 31% of programs offered by public universities are highly ranked by the ministry of education. In the case of programs at private universities, only 21% are equally recognized.[12] However, according to the Ministry of Education of Colombia, 30% of the public universities are accredited as high quality institutions while, in the case of private universities, 31% are. Similarly, of the total research groups recognized by the Administrative Department of Science, Technology and Innovation (COLCIENCIAS)[13], 51.4% belong to public universities while 48.6% belong to private universities.[14] Yet, when the top 50 universities in Colombia are analyzed using the methodology of the QS University Rankings Latin America, 31 out of the 50 universities are private.[15]

A second factor that generates differences between public and private institutions of higher education is the institutional approach, one of the main determinants of incentives for teachers and students. Although public and private universities have, on average, similar levels

[10] Public universities in Colombia are also characterized by having greater resources on average than private universities. For example, in 2008 *Cambio* magazine and the newspaper *Portafolio* classified the 1001 largest companies in Colombia measured by their income. Fourteen universities were listed in the ranking and 12 of them were public.

[11] CNA is the acronym in Spanish for *Consejo Nacional de Acreditacion*.

[12] These figures are constructed from SNIES, information in the "*Informacion a la mano*" section, http://www.mineducacion.gov.co/sistemasdeinformacion/1735/w3-article-212396.html. The data are restricted exclusively to institutions with an "academic nature" equal to a University. This means technical and technology institutions are excluded.

[13] COLCIENCIAS is the acronym in Spanish for *Departamento Administrativo de Ciencia, Tecnología e Innovación*.

[14] COLCIENCIAS has four categories A1, A, B, C or D, where A1 is the higher quality category. The distribution of groups within the different categories defined by COLCIENCIAS is fairly balanced between public and private universities: in the case of public universities, 286 groups are category A1 while 398 are category A, 792 category B, and 1375 and 631 are categories C and D. In the case of private universities, 296 groups are category A1 while 406 are category A, 818 category B, 1469 category C, and 688 category D.

[15] The ranking was consulted on 15 January 2016 at this link: http://www.topuniversities.com/university-rankings/latam-university-rankings/2015#sorting=rank+region=+country=+faculty=+stars=false+search= . It should be noted that among the 20 best, 50% are public. The methodology of the QS University Rankings Latin America is based on the weighting of seven indicators: academic reputation (30%), reputation with employers (20%), relationship between full-time employees and full-time students (10%), average citations per article (10%), articles by faculty (10%) proportion of staff with PhD (10%) and online presence (10%).

of experience measured in years of operation, there are fundamental differences in key areas such as budgeting, teacher incentives, curricula, and accountability.[16]

The economic literature states that the identification, retention and motivation of capable teachers are key tasks in the administration of educational institutions. The compensation systems in the public sector tend to be rigid and bureaucratic, with wages that often do not distinguish by grades or courses, nor are they based on historical performance (Neal, 2002). Private universities are not always restricted in these ways. For example, a private university in Colombia could make special offers to teachers who are hard to find for certain subjects while a public university would not have the same flexibility. To a large extent, this is due to the high degree to which the sources of funds for public institutions are centralized. Jaramillo (2003) showed evidence that private universities in Colombia are more decentralized in funding and have greater sources of income. Melo et al. (2014) estimated that the Colombian government invested an annual average of 0.93% of GDP in higher education between 2000 and 2012, but funding for private universities comes primarily from the collection of fees. According to the *Observatorio de la Universidad Colombiana*, a typical private university in Colombia charged between 2 and 28 times the monthly minimum wage for tuition in 2014, with an average of about 6.5 million pesos per semester.

The institutional framework is also reflected in the curriculum. Jaramillo (2003) indicated that in Colombia, private universities are more likely to offer degrees in social and administrative sciences, engineering, and technologies while public universities are more likely to offer degrees in education, humanities, agricultural sciences, and natural and exact sciences. Jaramillo (2003) concluded that this is due to the internationalization approach of the private sector.

Finally, it is important to consider teacher incentives and mechanisms for accountability. Literature on secondary education in the United States provides some examples. Neal (2002) stated that ideally, in an institution of public secondary education, administrators should be allowed to compensate the best teachers better, but there is the risk that variability in teacher's compensation might become a tool for administrators to favor the teachers who share their own political affiliation, or to practice nepotism. Hanushek (2002) claims that, although a way to make public school teachers in the United States accountable has been to evaluate the performance of their students through standardized tests at the level of each State, that approach is limited to reaching the proposed accountability goals. Indeed, Neal (2002)

[16] In particular, according to the Ministry of Education and SNIES figures, for the year 2014 public universities have been operation for an average of 45.6 years, whilst private universities for an average of 46.6 years.

found that some standardized tests at the state level do not produce results that are consistent with test results at the national level. The same thing was found by Koretz (2002), and Klein et al. (2002). Jacob and Levitt (2003) also presented evidence of cheating on standardized tests and cheating that is specifically associated with changes in teacher incentives.

There is no indication of how institutional differences affect university teachers in Colombia. What is evident, as previously mentioned, is that teachers in public universities are, on average, more educated and have more attractive contracts than private university teachers.

A final factor to consider is the role played by peers in public and private educational institutions. In general, public universities have higher thresholds for admission and, on average, receive better students. For the 2007-2012 period, using figures from the Ministry of Education, the rate of entry to public universities, measured as the ratio between the number admitted and the number enrolled was 25%, while for the private universities it was 78%. In the same period, the average ICFES exam score at public universities was 0.24 standard deviations higher than at private universities.

However, students entering private universities come from households with higher income, better educated parents, and smaller families. For the 2007-2012 period, 6.9% of the families of students who entered public universities had incomes that were above 3 minimum wages, unlike private university students, for whom the same ratio was 18.0%. Also, 6.5% of the students who entered public universities during this period reported that their mothers' educational level was tertiary university or higher, while this figure was 15.6% for students who entered private universities. Finally, 8.3% of the students who entered public universities lived in households with 4 or fewer members, and 17.7% of private university students had households with similar sizes.

On the other hand, authors like Eide et al. (1998) have provided evidence that elite universities, most of these private, increase the odds of attending graduate school. This may be linked to social network dynamics within private universities.

III. Data

The main information source we used was the databases provided by the Colombian Institute for the Evaluation of Higher Education (ICFES),[17] in particular, the information collected when students take the SABER 11 (or ICFES) and SABER Pro (or ECAES) tests. We also used other sources of information provided by the Ministry of National Education (MEN)[18] and the CNA,

[17] ICFES is the acronym in Spanish for el *Instituto Colombiano para la Evaluación de la Educación Superior*.
[18] MEN is the acronym in Spanish for *Ministerio de Educacion Nacional*.

which provide most of the information on supply and demand of education at the secondary and tertiary levels.

Based on this information, we built a database containing information about students, their families, and the school they attended at the moment they took the ICFES tests as well as their respective ICEFS and ECAES tests scores. It also included the type of higher education institution they attended. We used the ICFES scores as each student's baseline outcome, and the ECAES as his follow-up outcome.

The ICFES test provided our baseline information for about 2,120,797 students who took it between 2000 and 2004. In addition to the score obtained by each individual in each of the areas assessed, the database includes information related to the high school from which each individual graduated as well as their socioeconomic background at that moment.[19]

The ECAES test provided follow-up information for about 421,423 students who took it between 2004 and 2008. We focused on the 2004-2008 period because the structure of the ECAES test was relatively stable during these years, with field-specific questions.[20] Beginning in 2009, the ECAES examination went through a process of continuous changes, due to Decree 3963/2009, that made it impossible for us to compare those years to the previous ones. In particular, during the 2009-2011 period, the test included generic skills in written communication, problem solving, critical thinking, interpersonal understanding, reading comprehension and English which were applied to all fields. Also, starting in the second half of 2011, field-specific questions were eliminated, and the different fields were put together into 30 reference groups, so that 30 tests were constructed. Finally, even though the ECAES test was not mandatory in the 2004-2008 period, the number of people who took the ECAES at that time was approximately equal to the total number of people who graduated from the universities considered in our empirical exercise.[21] The ECAES dataset also contained information about the institution of Higher Education the student attended when he took the test.[22]

[19] The test assesses 8 areas of knowledge: Biology, Mathematics, Philosophy, Physics, Chemistry, History, Language and Geography.

[20] It is important to note that in the 2004-2008 period all programs were not assessed, therefore, in our exercise only those programs that were evaluated during the period of interest and had enough information are included.

[21] Our empirical exercise considers 201 Colombian universities, and a total of 14 academic programs. On average and including all academic programs at 201 universities analyzed between 2004 and 2008, 73,327 students graduated while 79,290 students took the ECAES test.

[22] Information regarding the nature and origin of the HEI was obtained by cross-checking the institution's code with information provided by the MEN, which contains these features for 333 HEI nationwide. The HEI can be by nature: a technological school, technological institution, university, professional and technical university; while the origin may be: a corporation (unofficial) foundation (unofficial) governmentally established at the state (department), municipal, and national level, and special regime.

The master database with all the students' baseline and follow-up information, contains a total of 129,387 students (50,637 men and 78,750 women). The database was complemented with additional information obtained from the MEN and CAN datasets, containing characteristics of the schools, and the accreditation status of each higher education program. The school information is obtained from the 166 MEN Resolution, which contains its nature (public or private), type of schedule, and whether it was all-male, all female or co-educational.

In order to check the robustness of our exercises, the data contain information that allows us to filter students, institutions or programs based on their academic quality. The first filter considers only individuals who were attending accredited programs at the moment they took the EACES. The second filter considers only individuals in programs limited to students who scored in the 25th percentile of the ICFES test – a score that was better than the average for all those taking that test. This allowed us to eliminate programs that admitted students with poor results on the ICFES tests and retain only those in selective programs. The third is restricted to programs that belong to the top 20 universities in Colombia based on the QS University Rankings Latin America, a ranking based on criteria that is slightly and indirectly associated with the ICFES test.[23]

Given the low comparability between the different subjects assessed in the ECAES tests for different programs, we measure value added by program. To ensure a minimum robustness in our results, only those programs that had a minimum of 100 students of either gender per program were analyzed in each group of public and private universities. As a result, for both men and women, we analyzed academic programs in medicine, dentistry, civil engineering, industrial engineering, computer engineering, law, education, management, accounting and economics. Nursing and psychology were analyzed only for women, and electrical and mechanical engineering programs were analyzed only for men. Overall, our exercise focused on and analyzed a total of 14 programs of which 12 academic programs included both genders.

Thus, the assessment exercises were done with eight different populations: the first contains men without distinguishing by the type of program (33,853 students), while the second contains all women (53,858 students), these two databases do not include any restrictions regarding the quality of the program (e.g. whether they were accredited, selective, or whether they belonged to one of the top 20 universities). The third and fourth databases

[23] The ranking was consulted on 15 January 2016 at this link http://www.topuniversities.com/university-rankings/latam-university-rankings/2015#sorting=rank+region=+country=+faculty=+stars=false+search=. It is based on seven indicators: (i) academic reputation, (ii) the reputation of employers of graduates, (iii) ratio of the number of teachers to students, (iv) citations of articles published by its researchers, (v) articles per teacher, (vi) proportion of teachers with doctorates, and (vii) the importance of their presence on the web.

contain 14,234 men and 21,339 women who were identified as students of programs that are accredited by the CNA (representing 42% and 40% of their total population respectively). The fifth and sixth databases contain 16,207 men and 24,756 women who studied in selective programs (representing 48% and 46%, of their total population respectively). Finally, the seventh and eighth databases contain 11,323 men and 15,293 women who studied in the top 20 universities in the country (representing 33% and 28%, of its total population respectively).

Among the selected programs (see Table 2), Bogotá represents the largest share of students, especially when one considers the private universities. Cali, Medellin, Barranquilla and Bucaramanga account for 25% of the male students in public universities and 33% in private universities; and for 20% and 34% of the women in public and private institutions respectively. For the national total, there is an average of 1.1 male and 1.7 female matched students in private universities that took the ICFES and ECAES tests for every 1,000 inhabitants while for the five main cities that average varies between 1.7 and 5.5 in the case of males, and between 2.5 and 8.8 in that of female students.

Table 2. Basic statistics by type of university and gender

Variable	Men							Women						
	Total	Public	Private	Public-Private	Total Students/1000 Inhab.	Public	Private	Total	Public	Private	Public-Private	Total Students/1000 Inhab.	Public	Private
Population	33,853	11,452	22,401	-10949	1.7	0.6	1.1	53,858	17,753	36,105	-18352	2.5	0.8	1.7
Bogotá	44%	27%	52%	-25.4%	4.6	1.0	3.6	40%	22%	49%	-26.9%	6.1	1.1	5.0
Barranquilla	9%	3%	12%	-8.8%	5.5	0.6	4.9	8%	2%	10%	-8.3%	7.0	0.6	6.4
Medellín	8%	8%	8%	0.4%	2.7	0.9	1.7	9%	8%	9%	-1.4%	4.0	1.2	2.8
Cali	8%	9%	8%	0.9%	2.8	1.0	1.8	7%	7%	8%	-0.4%	3.6	1.2	2.5
Bucaramanga	6%	5%	6%	-0.9%	7.8	2.4	5.5	5%	3%	7%	-3.1%	11.0	2.3	8.8
Other Cities	26%	48%	14%	33.8%	0.6	0.4	0.2	31%	58%	18%	40.0%	1.1	0.7	0.4
Icfes Score														
Average	49.7	50.5	49.3	1.2				47.9	48.5	47.5	0.9			
Biology	50.6	51.2	50.2	1.0				48.4	49.0	48.2	0.8			
Mathematics	46.8	47.6	46.3	1.2				44.3	44.9	44.0	0.9			
Philosophy	48.1	48.8	47.8	1.0				48.2	48.9	47.9	1.0			
Physics	50.3	51.0	50.0	1.0				47.4	47.7	47.3	0.4			
History	48.6	49.4	48.2	1.2				47.1	47.9	46.7	1.2			
Chemistry	51.3	52.3	50.7	1.6				48.1	48.7	47.7	0.9			
Language	52.8	53.4	52.4	1.0				51.9	52.5	51.6	0.9			
Geography	49.3	50.3	48.9	1.4				47.5	48.4	47.1	1.3			
Ecaes Score	102.9	104.6	102.0	2.5				100.6	102.3	99.7	2.6			

Source: ICFES, ECAES, C600 DANE database.

Table 2 also illustrates that in all areas assessed in the ICFES test, there is positive selection of students in public HEI, that is, higher average scores in HEI, and negative selection regarding social variables such as parents' education, household size and family income. This is discussed in greater detail with respect to the math and language results for each of the analyzed programs in Tables 3 and 4. In them, we present the average scores in math and

language in each program for public and private HEI, and for both men and women in accredited and non-accredited programs in each case. In most of the cases, public universities accept students with higher average results in both mathematics and language.

For men in non-accredited programs, the average results in mathematics and language for public HEI are at least two additional points above private HEI in 6 and 7 of the analyzed programs respectively (Table 3, columns xxvii and xxix), while private HEIs have an advantage of that magnitude in only the administration program (in mathematics) for accredited programs.

In the case of women in non-accredited programs, Table 4 shows that the average ICFES scores in math and language for those in public HEI are at least two additional points above the private HEI in 3 and 6 programs respectively (Table 4 columns xxvii and xxix). In no case do private institutions have an advantage of that magnitude. Within the accredited HEI, the results are even better for the public institutions.

The academic achievement variable measures the difference between ECAES and the ICFES standardized scores, where standardization is calculated for individuals who studied in the same program and took the ECAES.[24]

The ICFES variable is measured as the average score in three areas of general knowledge: mathematics, language and biology. The results are robust to other definitions. The difference between public and private in the average ICFES score is lower when only accredited programs are considered, and the variation is greater in private universities. The difference between the ICFES test results for students at public and private HEIs brings with it implicit differences in other areas. Since our work attempts to identify the students' gains in academic achievement in public versus private undergraduate programs, the variables we control for in the baseline were selected while bearing in mind the need to comply with the assumption of conditional independence. The variables considered are meant to allow us to minimize the possibility that matched treated and untreated students were not comparable.

The control variables for this exercise can be grouped under four categories: individual, home, school, and place where the ICFES test was taken (see Table in Appendix 1 with the definition of the different variables).

[24] The process of standardization of scores follows the usual procedure. The average is subtracted and divided by the standard deviation. Note that our standardization is to a program level, not the program/year, for those individuals who took the ECAES test. However, the matching procedure includes fixed effects associated with the years when the students took the ICFES exam.

Table 3. ICFES Test Results for mathematics and language by program for men in accredited and non-accredited programs at public and private higher education institutions

Program	Accredited Programs					Non-Accredited Programs				
	N. of Individ.	Math		Lang.		N. of Individ.	Math		Lang.	
		μ	σ	μ	σ		μ	σ	μ	σ
	Public									
	(i)	(ii)	(iii)	(iv)	(v)	(xi)	(xii)	(xiii)	(xiv)	(xv)
Medicine	438	53.8	8.8	56.8	5.5	61	48.5	7.5	54.7	6.1
Dentistry	107	46.6	5.9	53.9	5.2	43	47.4	6.6	52.7	4.4
Civil Engineering	294	50.2	7.1	54.9	5.8	484	49.1	7.3	54.0	6.5
Electrical and Electronic Engineering	488	52.5	7.8	56.5	5.9	804	50.6	8.1	55.0	6.5
Industrial Engineering	498	50.7	6.8	56.1	5.5	446	48.0	6.8	53.7	6.6
Computer Engineering	619	51.6	7.6	56.1	5.8	841	47.0	6.4	52.9	6.5
Mechanical Engineering	305	52.6	8.1	56.8	6.0	380	49.0	6.5	54.5	5.9
Law	235	47.6	7.1	56.1	6.2	589	45.5	6.0	55.0	7.0
Education	469	44.7	5.8	51.8	5.8	1053	43.2	5.3	49.9	6.4
Administration	1227	44.9	5.9	52.0	6.3	984	44.3	5.8	49.9	6.5
Accounting	348	47.1	6.4	52.1	6.0	313	44.4	5.9	50.9	6.1
Economics	237	48.8	7.6	55.5	6.3	209	46.3	6.6	52.2	6.2
	Private									
	(vi)	(vii)	(vii)	(ix)	(x)	(xvi)	(xvii)	(xviii)	(xix)	(xx)
Medicine	319	50.2	7.6	56.2	5.7	624	45.7	5.9	52.2	5.3
Dentistry	220	44.5	6.2	50.7	5.9	252	43.7	5.3	48.8	6.3
Civil Engineering	588	49.0	7.3	54.6	6.8	497	45.4	6.5	51.0	6.2
Electrical and Electronic Engineering	1164	50.6	7.9	55.6	6.2	1153	46.2	6.5	52.1	6.7
Industrial Engineering	908	48.4	7.6	54.0	6.4	1856	48.0	8.3	54.0	8.0
Computer Engineering	907	48.2	7.5	54.5	6.7	2520	44.9	6.6	50.8	6.4
Mechanical Engineering	309	52.9	9.8	56.7	6.7	891	46.5	6.8	52.5	6.3

Law	2154	45.8	6.7	54.0	7.4	1846	43.7	6.0	50.8	6.4
Education	102	44.1	6.7	50.8	7.1	355	42.7	5.1	48.6	6.4
Administration	1368	47.2	6.8	53.1	6.6	2088	44.3	6.1	50.1	6.3
Accounting	352	45.1	6.5	50.2	5.7	894	43.5	5.5	48.7	5.6
Economics	588	50.7	8.3	56.4	8.1	474	46.3	7.2	52.4	6.5
	Public-Private Difference									
	(xxi)	(xxii)	(xiii)	(xxiv)	(xxv)	(xxvi)	(xxvii)	(xviii)	(xxix)	(xxx)
Medicine	119	3.5	1.2	0.6	-0.3	-563	2.9	1.7	2.5	0.8
Dentistry	-113	2.1	-0.3	3.2	-0.7	-209	3.8	1.3	3.9	-1.9
Civil Engineering	-294	1.2	-0.2	0.3	-1.0	-13	3.6	0.8	3.0	0.3
Electrical and Electronic Engineering	-676	1.8	-0.1	0.9	-0.3	-349	4.3	1.6	2.9	-0.2
Industrial Engineering	-410	2.3	-0.9	2.1	-0.9	-1410	0.0	-1.4	-0.4	-1.3
Computer Engineering	-288	3.4	0.0	1.5	-0.9	-1679	2.1	-0.2	2.1	0.1
Mechanical Engineering	-4	-0.3	-1.7	0.1	-0.6	-511	2.5	-0.3	1.9	-0.3
Law	-1919	1.8	0.5	2.1	-1.2	-1257	1.8	0.0	4.2	0.6
Education	367	0.5	-0.8	0.9	-1.3	698	0.5	0.2	1.3	0.1
Administration	-141	-2.3	-0.9	-1.1	-0.3	-1104	0.0	-0.3	-0.2	0.2
Accounting	-4	2.1	-0.1	1.9	0.3	-581	0.9	0.4	2.2	0.5
Economics	-351	-1.9	-0.8	-0.8	-1.8	-265	0.0	-0.6	-0.2	-0.3

Note: Columns (xxi) to (xxx) refer to the difference of each area (observations, mean and standard deviation) between public and private. Cases where the value in public programs was lower than in private programs are shaded. Source: ICFES, ECAES Tests; authors' calculations.

Table 4. ICFES Test Results for mathematics and language by program for women in accredited and non-accredited programs at public and private higher education institutions

Program	Accredited Programs					Non-Accredited Programs				
	N. of Individ.	Math		Lang.		N. of Individ.	Math		Lang.	
		μ	σ	μ	σ		μ	σ	μ	σ
	Public									
	(i)	(ii)	(iii)	(iv)	(v)	(xi)	(xii)	(xiii)	(xiv)	(xv)
Nursing	1173	45.1	5.4	54.9	6.0	892	44.7	5.5	52.5	6.1
Medicine	448	51.5	7.2	56.9	5.0	79	47.0	5.9	54.9	5.4
Dentistry	234	46.2	5.9	54.6	5.3	145	45.4	5.9	53.4	5.5
Civil Engineering	196	48.6	7.5	54.4	5.7	246	48.0	7.0	55.6	6.5
Industrial Engineering	612	49.8	6.9	57.0	6.4	553	46.8	6.2	54.2	6.3
Computer Engineering	257	48.1	6.9	55.0	6.3	569	44.5	5.7	51.5	6.7
Law	316	46.0	5.6	57.0	6.3	936	45.0	5.9	56.0	7.0
Psychology	152	45.2	5.3	56.7	5.8	1227	43.6	5.9	51.0	7.2
Education	1101	43.7	5.3	52.1	5.7	2561	42.9	5.3	50.4	6.0
Administration	1147	45.2	5.7	52.3	6.0	2529	43.5	5.4	49.7	6.1
Accounting	860	46.0	5.5	51.6	5.9	785	43.8	5.5	50.5	6.3
Economics	331	46.8	6.7	55.4	5.6	426	46.3	6.3	53.3	5.8
	Private									
	(vi)	(vii)	(vii)	(ix)	(x)	(xvi)	(xvii)	(xviii)	(xix)	(xx)
Nursing	943	42.5	5.0	50.1	5.9	1991	42.0	5.1	48.7	6.1
Medicine	558	48.8	6.8	55.7	5.9	1033	45.4	5.6	52.9	5.3
Dentistry	858	43.2	5.4	50.6	6.3	768	42.8	5.6	49.8	5.6
Civil Engineering	298	46.4	6.4	54.7	7.2	213	44.6	6.5	51.1	6.4
Industrial Engineering	1083	46.9	6.7	54.0	6.4	2099	46.2	6.7	54.1	7.1
Computer Engineering	432	45.9	6.0	53.5	6.3	1540	43.8	5.6	50.1	6.4
Law	3819	44.4	5.9	54.2	6.8	3361	43.3	5.3	51.4	6.2

Psychology	2846	43.8	5.5	52.9	6.6	2001	42.7	5.3	50.0	6.2
Education	328	43.4	5.1	50.6	7.0	2070	41.9	5.1	47.8	5.9
Administration	1891	45.5	6.0	53.4	6.5	3549	43.4	5.6	50.2	6.3
Accounting	763	43.4	5.6	50.4	6.1	2159	43.0	5.2	49.3	5.7
Economics	709	47.3	6.7	55.1	6.4	824	44.8	6.1	52.4	6.1
	Public-Private Difference									
	(xxi)	(xxii)	(xiii)	(xxiv)	(xxv)	(xxvi)	(xxvii)	(xviii)	(xxix)	(xxx)
Nursing	230	2.6	0.4	4.8	0.1	-1099	2.7	0.4	3.8	-0.1
Medicine	-110	2.7	0.4	1.2	-0.9	-954	1.6	0.2	2.0	0.1
Dentistry	-624	3.0	0.5	4.0	-1.0	-623	2.6	0.3	3.7	-0.1
Civil Engineering	-102	2.2	1.1	-0.3	-1.4	33	3.4	0.5	4.5	0.2
Industrial Engineering	-471	2.9	0.2	3.0	0.0	-1546	0.6	-0.5	0.1	-0.8
Computer Engineering	-175	2.2	0.9	1.5	0.0	-971	0.8	0.1	1.4	0.3
Law	-3503	1.6	-0.3	2.8	-0.5	-2425	1.7	0.5	4.7	0.8
Psychology	-2694	1.3	-0.2	3.8	-0.8	-774	0.8	0.6	1.1	1.0
Education	773	0.4	0.3	1.5	-1.3	491	0.9	0.2	2.6	0.1
Administration	-744	-0.3	-0.3	-1.1	-0.6	-1020	0.1	-0.2	-0.4	-0.2
Accounting	97	2.5	-0.1	1.2	-0.2	-1374	0.8	0.3	1.2	0.5
Economics	-378	-0.5	-0.1	0.2	-0.8	-398	1.5	0.1	0.9	-0.3

Note: Columns (xxi) to (xxx) refer to the difference of each area (observations, mean and standard deviation) between public and private. Cases where the value in public programs was lower than in private programs are shaded. Source: ICFES, ECAES Tests; authors' calculations

Table 5 illustrates, by gender, the most important features of the data for selected programs. Except for programs related to engineering, the selected programs are mainly composed of women. Additionally, public funding is particularly high for the education program. In the remaining programs, there are more students in the private institutions. There is a high concentration of higher education students in Bogotá. This is particularly true in engineering since 44% of the total engineering students are in that city. However, some cities have a significant number of students in other programs, for example, Cali in economics (16%), Medellín in dentistry (14%), mechanical engineering (12%), and psychology (12%); Barranquilla in industrial engineering (16%), mechanical engineering (18%) and nursing (13%); Bucaramanga in civil engineering (9%), and finally, Bogotá in dentistry, electrical engineering, and law.

Table 5. Individuals by program, for each gender and city

Area	Program	N	%Public	Woman	Bogotá	Cali	Medellin	B/quilla	B/manga
Health Sciences	Nursing	4,994	41%	100%	27%	6%	5%	13%	7%
	Medicine	3,555	29%	59%	45%	8%	7%	11%	8%
	Dentistry	2,625	20%	76%	57%	7%	14%	5%	4%
	Subtotal	**11,174**	**32%**	**82%**	**40%**	**7%**	**8%**	**10%**	**7%**
Engineering	Civil Engineering	2,814	43%	34%	42%	4%	8%	4%	9%
	Electrical Engineering	3,605	36%	0%	47%	8%	8%	9%	6%
	Industrial Engineering	8,044	26%	54%	44%	10%	4%	16%	8%
	Systems Engineering	7,678	30%	36%	42%	7%	8%	7%	6%
	Mechanical Engineering	1,884	36%	0%	40%	10%	12%	18%	6%
	Subtotal	**24,025**	**32%**	34%	**44%**	**8%**	**7%**	**11%**	**7%**
Human	Law	13,242	16%	64%	47%	5%	8%	7%	8%
	Psychology	6,218	22%	100%	42%	10%	12%	8%	5%
	Education	8,029	64%	75%	37%	4%	8%	4%	3%
	Subtotal	**27,489**	**31%**	**75%**	**43%**	**6%**	**9%**	**7%**	**6%**
Administration sciences and Economics	Administration	14,757	40%	62%	38%	9%	10%	4%	4%
	Accounting	6,470	36%	71%	39%	9%	10%	9%	2%
	Economics	3,796	32%	60%	42%	16%	8%	3%	5%
	Subtotal	**25,023**	**37%**	**64%**	**39%**	**10%**	**10%**	**5%**	**4%**

Note: In the column for women's participation, the results of four programs appear in gray to highlight that these are 100% men or 100% women given the previously explained selection program criteria by gender. Source: ICFES, ECAES Tests; authors' calculations.

a. Stylized Facts

As was mentioned above, the labor market and the higher educational system in Colombia are deeply linked. The basic labor market indicators – Participation Rate, Employment and Unemployment – for the last 25 years show that there have been significant differences based on educational level. For example, individuals with higher education have usually had higher share of the market and employment rates as well as lower unemployment rates (see Medina and Posso, 2010).

It should be noted that between the second quarter of 1994 and 1999, there was an increase of about 10 percentage points in the unemployment of unskilled labor from levels close to 6% to levels of around 17%. For skilled labor, the increase in unemployment was approximately 11 percentage points. However, it remained at lower levels than those recorded for the least skilled workers, going from a rate of 4% to 15% by mid-1999 when the Colombian economic crisis reached its peak.

In turn, the participation rate and employment of individuals with higher education between 1984 and 2006 were significantly higher compared to those without higher education. Between 1994 and 1999, when unemployment increased for both the skilled and the unskilled laborers, the participation rate of trained men was higher than that of the unskilled. This pattern is similar to the one observed for the employment rate which, although it declined for the analyzed period, remained higher for the skilled workers.

There are also important differences in labor income by educational level. Medina and Posso (2010) showed that, based on the unconditional earnings associated with higher education, finishing college has substantial effects on earned income. Posso (2008) showed that earnings related to secondary and basic education are much lower than those obtained with any higher education degree.

However, despite the better income associated with higher education, it must be noted that there are deep differences in wages among individuals with higher education. Medina and Posso (2010) used the standard deviation of log hourly wage for individuals with and without higher education to illustrate that a significant proportion of the growing wage inequality in Colombia has occurred within the most highly educated group. This may be associated with the significant growth of higher education enrollment rates in Colombia that began in the mid-nineties as documented by Posso (2008). This unprecedented growth in higher education enrollment rates, especially in private institutions, produced a significant effect on the formal and informal labor markets. As of 2010, while the employment of people with primary education remained at 1985 levels, that of people with a secondary education had doubled, and

employment of those with at least some university education was about four times that of 1985.[25]

Table 6. Public and private university attendance by department (state), 2005

School Attendance by Department (Census 2005)	5 years Programs		2-3 years Programs		5-years Programs students per capita	2 to 3-years Programs students per capita
	Population	% Private	Population	% Private	Percentage	Percentage
Bogotá	292,445	73%	71,773	58%	4.3	1.0
Atlántico	55,764	68%	22,589	58%	2.6	1.0
Santander	45,476	54%	16,398	34%	2.3	0.8
Norte de Santander	25,897	17%	5,590	29%	2.1	0.4
Valle del Cauca	84,560	59%	35,547	54%	2.0	0.9
Caldas	19,624	36%	4,312	36%	2.0	0.4
Antioquia	109,048	51%	49,981	41%	1.9	0.9
Quindio	10,207	34%	2,973	29%	1.9	0.6
Boyacá	23,788	30%	4,139	29%	1.9	0.3
Risaralda	16,132	45%	6,004	35%	1.8	0.7
Bolivar	31,723	60%	16,914	53%	1.7	0.9
Meta	11,710	53%	3,989	52%	1.5	0.5
Chocó	6,306	3%	739	5%	1.4	0.2
Cauca	16,886	29%	4,785	43%	1.3	0.4
Huila	13,413	44%	3,735	43%	1.3	0.4
Tolima	18,070	42%	6,915	35%	1.3	0.5
Cesar	11,849	17%	4,609	40%	1.3	0.5
Cundinamarca	29,547	58%	12,232	53%	1.3	0.5
La Guajira	8,428	16%	3,417	26%	1.2	0.5
Magdalena	13,779	36%	5,195	44%	1.2	0.5
Nariño	18,167	42%	4,536	45%	1.2	0.3
Córdoba	16,690	41%	6,823	43%	1.1	0.5
Sucre	7,846	43%	3,317	48%	1.0	0.4
Caquetá	4,096	12%	961	21%	1.0	0.2
Casanare	2,652	39%	1,225	25%	0.9	0.4
Arauca	1,273	29%	960	23%	0.5	0.4
San Andrés	244	35%	250	18%	0.3	0.4
Putumayo	889	40%	896	24%	0.3	0.3
Amazonas	181	27%	93	15%	0.3	0.1
Guaviare	213	18%	108	10%	0.2	0.1
Vichada	97	10%	37	3%	0.2	0.1
Total	897,000	56%	301,042	48%	2.1	0.7

Note: The percentage of university students per capita is estimated based on the population of those 16-24 years of age. Source: Population Census 2005. Authors' calculations.

The growth experienced by institutions of higher education and professional and technical programs brought with it deep changes in the labor market. Table 6 shows that the main departments (regions) and, probably, the major metropolitan areas saw the most growth in higher education. The departments (regions) with more university students in private HEIs per capita are Bogotá, Atlántico, Santander, Norte de Santander, Valle del Cauca, Caldas and

[25] Modern employment is a proxy of formality as argued by López and Lasso (2008). This is defined as wage employment linked to self-employment of individuals with higher education.

Antioquia. Note also that technical and technological education is mainly offered by public institutions. As is the case in our data, the census shows that about 72% of higher educational institutions are concentrated in the main urban centers around the country.

IV. Methodology

To estimate the differential effect of studying in a public versus private higher education program on academic achievement, we obtained differences in differences (DID) matching estimators (Heckman, Ichimura and Todd, 1997, 1998). The DID matching estimator allows us to obtain unbiased estimates when we are able to control for the baseline variables that determine whether the individual will be selected into the treatment group. In addition, the DID allows us to control for unobserved characteristics that are fixed over time.

The outcome of interest is the student's progress between the time they started the undergraduate program, as measured by the ICFES test, and the time they completed it, as measured by the ECAES test of the specific program the individual selected. Our outcome variable, ΔY_i, is defined as the difference between the ECAES and ICFES standardized scores (Z_i^{ECAES} and Z_i^{ICFES}, respectively), where standardization is calculated for individuals who studied in the same program:

$$\Delta Y_i = \left(Z_i^{ECAES} - Z_i^{ICFES}\right)$$

Note that standardization also allows the individual's i progress with respect to the distribution of their peers in the program to be observed.[26] The treatment variable, T_i, is an indicator variable that takes the value of one if the individual was treated and 0 otherwise. Treatment depends on the nature of the higher educational institution (HEI) where the individual finished his studies, which can be public or private.[27] The parameter of interest is the impact on the standardized test scores of the value added of studying in a higher education public/private program, i.e., the average treatment on the treated individual, ATT.[28] For example, if we wanted to estimate the ATT associated with attending a public versus a private

[26] Alternatively, a linear regression could be estimated where the outcome variable is standardized ECAES scores, and the ICFES score is an additional control on the right side of the equation. Overall, the findings of our exercise are not modified by this specification change. However, it should be noted that our identification strategy allows us to control for unobservable factors that are constant over time, while the alternative specification would require additional assumptions.

[27] The implicit assumption is that individuals do not move between universities or programs.

[28] ATT is the abbreviation for the average treatment of the treated individual.

HEI, T_i takes the value of 1 if the individual i studied at a public HEI and 0 otherwise. If the ATT was meant to assess the effect of studying at a private versus a public HIE, T_i would take the value of 1 if the individual i studied at a private HEI and 0 otherwise. In this paper, both results are presented.

Let us define Y_{Tt} as the outcome under treatment T at time t, where $t = 0, 1$, with $t = 0$ representing the baseline given by the time immediately before enrollment in the higher education program, and $t = 1$ the follow up, given by the end of the program. A vector X of individual characteristics associated with the individual, his family, and the school he attended before going to the university is observed at the baseline. The ATT is defined as:

$$E[Y_{11} - Y_{00}|X, T = 1] - E[Y_{01} - Y_{00}|X, T = 0] \quad (1)$$

Component $\mathrm{E}[Y_{11} - Y_{00}|X, T = 1]$ is the expected value added to the score between the moment students graduated from high school, Y_{00}, and the moment they graduated from the public higher education program, Y_{11} given their observable characteristics, X. $\mathrm{E}[Y_{01} - Y_{00}|X, T = 0]$ is similarly defined for those who graduated from a private HEI. The DID matching estimator of the ATT is robust to the presence of unobservable components that are persistent over time (separable) and that could bias our estimate.[29] Identification of the ATT parameter requires the estimating $\mathrm{E}[Y_{01} - Y_{00}|X, T = 1] = \mathrm{E}[Y_{01} - Y_{00}|X, T = 0]$, i.e., it requires that the treatment, T, conditional on X, not be used to predict changes in $Y_{01} - Y_{00}$.[30] The estimator DID matching ATT, $\hat{\tau}_{DM}^{ATT}$, is given by

$$\hat{\tau}_{DM}^{ATT} = \frac{1}{N_1} \sum_{T_i=1} \left\{ (Y_{11i} - Y_{00i}) - \left(\hat{Y}_{01i} - \hat{Y}_{00i} \right) \right\} \quad (2)$$

where $N_1 = \sum_{i=1}^{N} T_i$ is the total number of individuals who were treated. To estimate $\left(\hat{Y}_{01i} - \hat{Y}_{00i} \right)$, matching estimators are used. In the literature, there are different methods that adjust to the above conditions and are analyzed in detail by Imbens (2004).[31] In this exercise,

[29] For example, cognitive and non-cognitive skills that are fixed over time after finishing high school but differ between test subjects and controls. Likewise, it controlled by geographical elements that, although fixed in time, may vary between test subjects and controls.

[30] It also requires that $0 < \Pr(T = 1|X) < 1$.

[31] According to Imbens (2004) these methods can be grouped into 5 categories: (1) based on the estimate of regression functions of the outcome variable depending on the control variable methods, (2) matching with covariates, (3) based on the propensity score or probability of participation in the program methods, (4) combinations of methods (1), (2) and (3), and (5) Bayesian methods.

the matching estimator proposed by Abadie and Imbens (2006, 2011), which makes it possible to obtain the Bias-Corrected Matching (BCM), is used. This estimate assumes that the selection of students for treatment is exclusively based on the observable characteristics of students at the baseline, and it is robust to the presence of unobservable components that are persistent over time.[32]

Table A.2 in Appendix 2 presents the definitions of our control variables. However, even after controlling for selection based on these variables, the matching estimators might still exhibit some forms of biases which the BCM estimator allows us to control for (see Abadie and Imbens 2006, 2011). Some generalities of BCM method are presented here.

a. Bias-Corrected Matching: general aspects

The main objective of this methodology is to find a consistent estimator of the counterfactual scenario $(\boldsymbol{Y_{01i} - Y_{00i}})$ for the treated individuals. The estimator of the counterfactual scenario $(\boldsymbol{Y_{01i} - Y_{00i}})$ is given by the equation

$$\left(\hat{Y}_{01i} - \hat{Y}_{00i}\right) = \frac{1}{\boldsymbol{M}} \sum_{j \in J_{Mi}} \left(Y_{01j} - Y_{00j}\right) \; si \;\; T_i = 1 \quad (3)$$

where $\boldsymbol{J_{Mi}} = \{\boldsymbol{l_{1i}}, \boldsymbol{l_{2i}}, \ldots, \boldsymbol{l_{Mi}}\}$ is the set of M nearest neighbors for individual i, such that $\boldsymbol{M} \leq \boldsymbol{N_0}$ and $\boldsymbol{N_0} = \sum_{\boldsymbol{i=1}}^{\boldsymbol{N}} (\boldsymbol{1} - \boldsymbol{T_i})$.

The choice of each best neighbor, $l_{\boldsymbol{mi}}$,, must meet the following conditions:

(i) $T_{l_{\boldsymbol{m}}(i)} = 1 - T_i$, where T_i is equal to one if the individual was exposed to treatment.

(ii) $m = \sum_{j:\, T_j = 1 - T_i} \boldsymbol{1}\left\{\left\|X_j - X_i\right\|_A \leq \left\|X_{l_{\boldsymbol{m}}(i)} - X_i\right\|_A\right\}$

[32] Thus, the result in the counterfactual scenario, $(Y_{01i} - Y_{00i})$, is independent of the treatment once it is conditioned to observable characteristics. That is, $Y_{01i} - Y_{00i} \perp T_i | \, X = x, \forall x$. This assumption is called conditional independence. Alternatively, one can say that the treatment assignment can be ignored (Rubin, 1983). Furthermore, it requires all variables in X to have a continuous distribution. Discrete variables fit into this definition since in our practice the values of these variables are conditioned on all the variables in X. To ensure that our estimates are robust to the type of matching used, our estimates also include the results using propensity score matching with and without bias correction, which we compare to the Ordinary Least Square (OLS) estimators.

where 1 { } is an indicator function equal to 1 if the expression in brackets is true and 0 otherwise. $\|x\|_A = (x'Ax)^{1/2}$ and A corresponds to the Mahalanobis distance.[33]

Just as in Abadie and Imbens (2006), the Abadie and Imbens (2011) estimator uses matching with replacement, i.e., it allows each individual within the control group to be used more than once as a match for the treated individual. Abadie and Imbens (2006) showed that estimators matching with neighbors generate a bias in finite samples that causes the estimator $\left(\hat{Y}_{01i} - \hat{Y}_{00i}\right)$ in equation (3) to be an inconsistent estimator for $(Y_{01i} - Y_{00i})$ in general. This bias is associated with the fact that the number of neighbors *M* is fixed.

Intuitively, the matching estimator will be biased in finite samples when the pairings are not exact, which is particularly important when a large number of covariates are included. The BCM estimator proposed by Abadie and Imbens (2011) adjusts the differences between different pairings using the differences between the values of their respective covariates. To make adjustments feasible, the dimensions of covariates are reduced using regression methods. Thus, the DID matching estimator with bias correction, $\hat{\tau}^{ATT}_{DM,BCM}$, would be given by

$$\hat{\tau}^{ATT}_{DM,BCM} = \hat{\tau}^{ATT}_{DM} - \hat{B}^{ATT}_{DM} \qquad (4)$$

where $\hat{B}^{ATT}_{DM}$ is the bias correction which is given by the following function

$$\hat{B}^{ATT}_{DM} = \frac{1}{N_1}\sum_{i=1}^{N}\frac{T_i}{M}\sum_{m=1}^{M}\left[\hat{\mu}_1(X_i) - \hat{\mu}_0(X_{j_m(i)})\right] \qquad (5)$$

and $\hat{\mu}_1(x)$ is a consistent estimator of $\mu_1(x) = E[Y_i(1)|\, X = x]$.[34] Note that the adjustment is the average difference between the predicted regression value of $\hat{\mu}_1(x)$ for each individual treated with respect to their nearest neighbors. All our exercises are based on the proposed equation estimator (4). The robust to heteroskedasticity standard errors are estimated following the proposal of Abadie and Imbens (2011, p.10).

[33] Mahalanobis distance is defined as $A_{maha} = \left[\frac{1}{N}\sum_{i=1}^{N}(X_i - \bar{X})\ (X_i - \bar{X})'\right]^{-1}$.

[34] Abadie and Imbens (2011) showed that the ECM estimator is robust even when $\hat{\mu}_0(x)$ regression is incorrectly specified.

V. Results

Before illustrating our estimates of the parameter of interest, $\hat{\tau}^{ATT}_{DM,BCM}$, it is important to show whether the matching procedure leads to balance in the covariates in X. Abadie and Imbens (2011) proposed a simple informal balancing test which is done in four steps:

1. All covariates of vector X are normalized so that they have a mean equal to 0 and a variance equal to 1.
2. Differences in the unconditional mean for each covariate between all treated and control individuals are calculated before the matching procedure.
3. Using the matching method described in the previous section, the best M matches for each individual are found. We fix M = 4.
4. Finally, the differences in the means of the covariates between each individual and his matched peers are calculated. Once these differences are obtained, the mean and standard deviation of the differences are calculated.

A first group of binary variables that control for the socioeconomic conditions of individuals in the baseline are restricted so that the matching is exact.[35] The test results are focused on balancing other variables not restricted to exact matching. All results are presented for four neighbors (M = 4) although our results are robust to other numbers of neighbors.[36] Figures A.1.1 and A.1.2 in Appendix 1 illustrate this exercise for both the total sample (Figure A.1.1), which includes all programs, and for programs restricted to selective samples (Figure A.1.2). Each figure includes six boxplots which provide information on the minimum and maximum value, quartiles 1 and 3 as well as the median and outliers. Note that the left column in each figure presents the results for men, while the right column shows the results for women. Also, the first row at the top shows the results before matching (step 2) while the second and third rows show the results after matching for the case in which treatment is defined as having attended a public university and private university respectively (step 4).

In both figures, it is clear that before matching, differences between treated individuals and controls were significant for an important number of covariates (step 2). These differences were evident in the range and interquartile range and in the presence of outliers. For example, before the matching, multiple covariates differed by more than 0.5 standard deviations. After comparing only the closest neighbors, both the rank and the difference in the interquartile

[35] Variables with exact matching are age (measured in quartiles), ICFES score in mathematics, language, and biology (measured in quartiles), binary variable of strata (= 1 if strata > = 3), nature and character of school, variable binary for the 13 major cities.

[36] Estimates with M=1 y M=16 do not differ significantly from those presented with M = 4.

range were significantly diminished, and now there was no program in which any individual presented differences of more than 0.5 standard deviations in any variable. Finally, in the vast majority of programs, the outliers with differences of more than 0.5 standard deviations disappear. It is important to note that the balance is better when treatment is defined as having attended a private HEI.

To ensure that our estimates are robust to the matching method used, our estimates also include the results from using Propensity Score Matching (PSM) with and without bias correction (Rosenbaum and Rubin, 1983). Since the PSM estimator is the difference in the outcome variable for those included in the common support, once the treated individuals have been adequately weighted by their probability of participating, then the ATT estimator is defined only in the region of the common support. Hence it is necessary to ensure the condition of common support. Table A.3.1 in Appendix 3, presents the common support for the different exercises and programs considered in the exercise. It is important to emphasize that in most of the exercises, the common support includes much of the unit interval, which means that almost any combination of features observed in the treated group is also observed in the control group (Caliendo and Kopeining, 2005).

The following section presents the results of the $\hat{\tau}^{ATT}_{DM,BCM}$ parameter. It also shows the additional exercises with alternative methods such as PSM or OLS. Our exercise enables us to estimate the effects of two types of treatment: (1) study at a public university, and (2) study at a private university. In general, the $\hat{\tau}^{ATT}_{DM,BCM}$ parameter for these two treatments differs. In the case of the public university, $\hat{\tau}^{ATT}_{DM,BCM}$ parameter gives more weight to those individuals who are more likely to attend a public university, whereas in the case of the private university, this parameter puts more weight on those individuals most likely to attend a private university.[37] If the selection on observable characteristics differs between public and private universities, then these two parameters should not be symmetrical. In our exercise, the results for these two types of treatments are similar with the exception of a few cases. Thus, in section 5.1 the results in the case of public universities are presented, both for the total sample and the sample restricted to selective programs, accredited, or the best universities in the country. At the end of this section the focus is on the differences found when the treatment definition is attending a private university.

[37] In general, when applying equation (1), moments conditioned $\mathrm{E}[Y_{11} - Y_{00}|X, T = 1]$ y $\mathrm{E}[Y_{01} - Y_{10}|X, T = 0]$ are different because the effects of covariates in each case could differ. In more flexible scenarios, it is likely that the difference is also driven by the unobservable variables. In our exercise the imbalance is assumed to be mainly associated with observable characteristics. A general analysis of the different types of parameters and how they relate can be found in Heckman and Vytlacil (2005).

Before presenting our results, it is important to remember that they were obtained from the universe of individuals that took the EACES test which, as we previously showed, are largely representative of the graduates from the programs assessed. The fact that our results are not meant to take into account self-selection of individuals due to different graduation rates between public and private HEI, nor with respect to any difference arising from the length of time students took to graduate must be kept in mind.

a. Average public university effect on those who attended public university

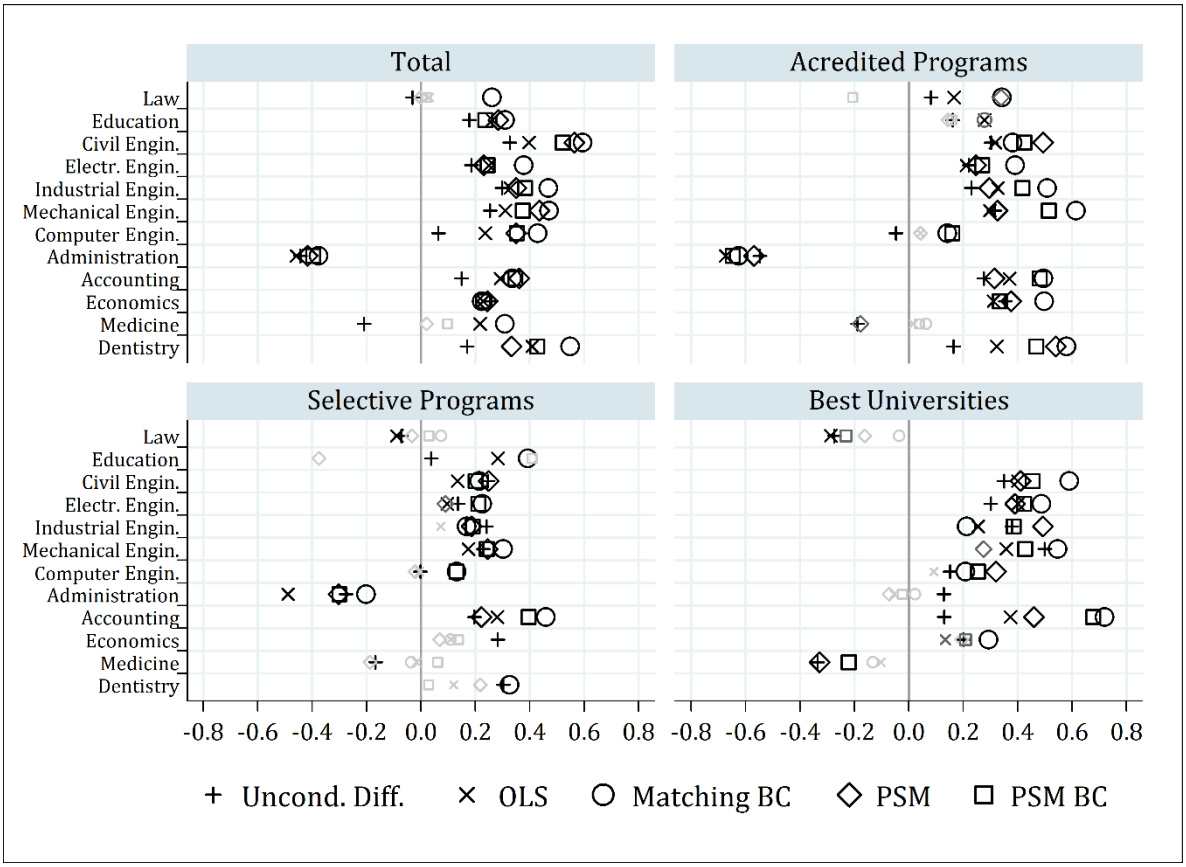
Our parameter estimates $\hat{\tau}_{DM,BCM}^{ATT}$ are obtained for each academic program (e.g. Economics). The programs that are analyzed for both male and female include law, education, civil engineering, industrial engineering, computer engineering, management, accounting, economics, medicine and dentistry. For the specific case of men, the analysis also includes electrical engineering and mechanical engineering while in the case of women, it includes nursing and psychology (see section 2. data). For each program, five estimators are calculated using the definition of the outcome variable described in the methodology section: (i) the DID matching estimator, $\hat{\tau}_{DM,BCM}^{ATT}$, (ii) the OLS conditional estimator in covariates, $\hat{\tau}_{DM,MCO}^{ATT}$, (iii) the PSM estimator, $\hat{\tau}_{DM,PSM}^{ATT}$, (iv) the PSM estimator with bias correction, $\hat{\tau}_{DM,PSM-BC}^{ATT}$, and (v) the difference between standardized ECAES and ICFES scores, which are standardized for individuals who studied in the same program, is calculated and used to find the unconditioned difference between public and private universities.

The results are summarized in Figures 1 and 2. The tables corresponding to these graphics are presented in Appendix 4. The results are presented for both men and women using all the universities considered in this exercise with their accredited programs, selective studies programs, and the top 20 universities in Colombia (see definition in section 2). All results used the case of four neighbors ($M = 4$) for matching procedures although the results are robust for other values of M (e.g. $M = 16$). Likewise, all the results are expressed in terms of standard deviations in order to facilitate the interpretation of the magnitudes of the coefficients in terms of the variability associated with each program.

In general, the value added of public universities relative to private is found to be positive and significant although the effect is not observed in all programs. Likewise, the results are robust for the different matching methods, especially in the male sample. The heterogeneity in the effect on men and women is remarkable, especially when the total sample is compared

to the sample that is restricted to accredited programs, targeted programs or the top 20 universities.

Figure 1. Treatment Results: Public, men

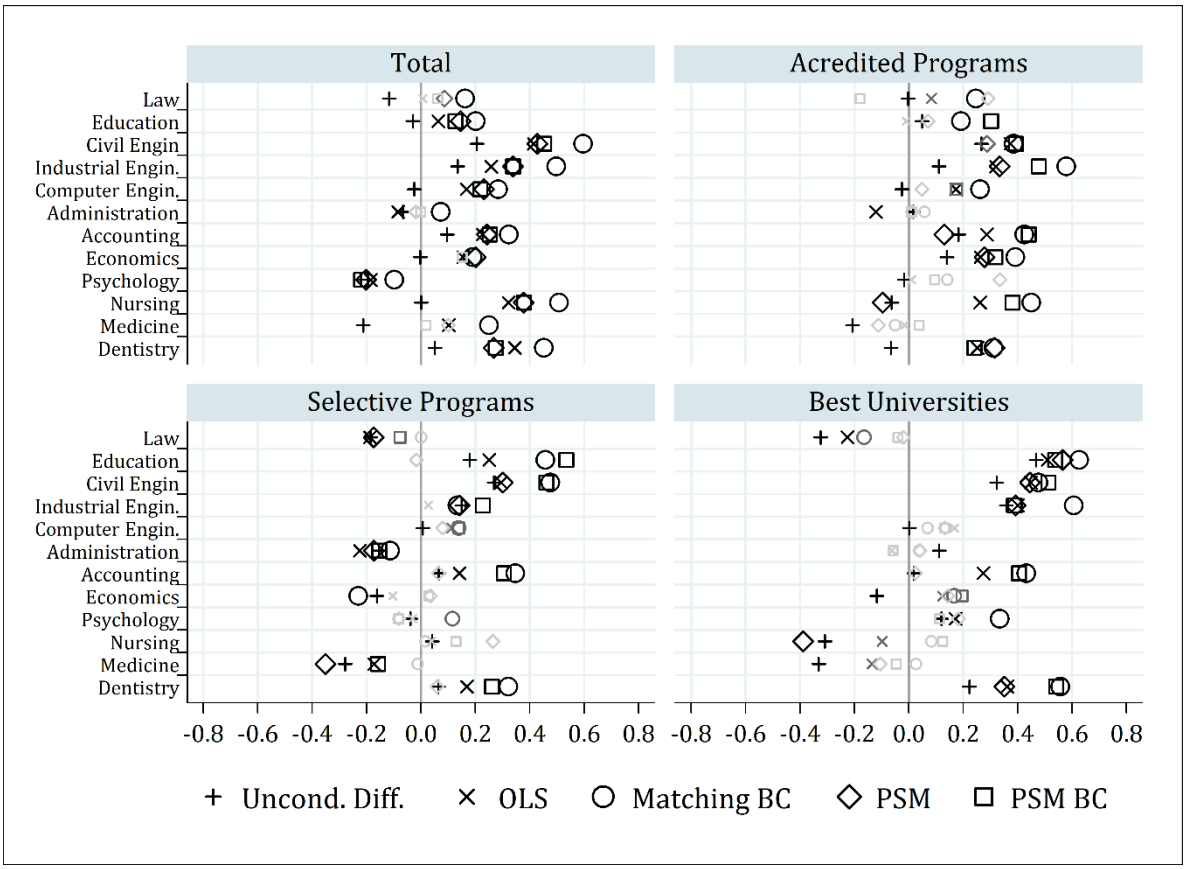


Note: The chart shows the results for men in four groups: Total, Accredited Programs, Selective Programs, and Best Institutions. Each figure represents a different type of comparison. For example, **crosses** show the unconditional average difference between public and private in each program. The **x's** show the OLS exercise controlling for covariates. The **circles** show the Matching exercise with bias correction, and **diamonds** and **squares** show profit for the year using Propensity Score Matching and without bias correction respectively. The intensity of the color and size of the figures are related to the significance of the underlying exercise as well. A small, light gray figure indicates no statistical significance. A gray intermediate size figure indicates 10% significance, and a large, black figure indicates 5% significance.

For the total sample, public universities produce improvements in academic performance in 9 to 11 programs out of 12 considered in the case of men, and in 7 to 11 programs out of the 12 analyzed in the case of women (see figures 1 and 2). The differences lie in the matching method used. While the $\hat{\tau}^{ATT}_{DM,BCM}$ estimator finds positive effects in 11 of the

programs, the $\hat{\tau}^{ATT}_{DM,PSM-BC}$ estimator finds an effect on 9 programs in the case of men and 7 programs in the case of women. The greatest effect is observed in the civil engineering program (both women and men) with a magnitude of about 0.6 standard deviations (SD). In most programs, the effect is positive, and the magnitude of the effect is between 0.2 and 0.4 SD. In the case of men, public universities have a negative effect of around -0.38 SD on the management program while, in the case of women, the effect is negative for the psychology program with a magnitude of - 0.1 SD.

Figure 2. Treatment Results: Public, women



Note: The chart shows the results for women in four groups: Total, Accredited Programs, Selective Programs and Best Institutions. Each figure represents a different type of comparison. For example, **crosses** show the unconditional average difference between public and private in each program. The **x's** show the OLS exercise controlling for covariates. The **circles** show the Matching exercise with bias correction, and **diamonds** and **squares** show profit for the year using Propensity Score Matching and without bias correction respectively. The intensity of the color and size of the figures are related to the significance of the underlying exercise as well. A small, light gray figure indicates no statistical significance. A gray intermediate size figure indicates a 10% significance, and a large, black figure indicates a 5% significance.

Likewise, the results of the different estimators have the same sign in most cases although it is clear that the bias-corrected estimators substantially correct the bias associated with the covariates in finite samples in every program. In all cases $\hat{\tau}^{ATT}_{DM,BCM} > \hat{\tau}^{ATT}_{DM,MCO}$, which is evidence of the importance of selection bias in the observable characteristics associated with the decision to attend a public HIE. It is interesting to note that for law and medical programs in the case of men, and law, computer engineering, management and medical programs in the case of women (in the unconditional difference between public and private universities) the sign for variable result is opposite the $\hat{\tau}^{ATT}_{DM,BCM}$ estimator. This demonstrates the importance of controlling for a large number of observable characteristics.

However, the above results are sensitive to the quality of the academic program in both cases whether dealing with the sample that considers only accredited programs, the one that is restricted to targeted programs, or the one that is limited to the top 20 universities in the country.

In the case of the accredited program sample (see Figures 1 and 2), positive effects are observed in 8 to 10 of the 12 academic programs analyzed in the case of men, and in 8 to 9 of the 12 programs analyzed for women. In particular, it should be noted that the effect on medical programs is not significant for either men or women, and the effect on law programs is not robust to matching methods for either men or women. Similarly, the effect on psychology and management programs is not statistically significant in the case of women.

Selective programs

When the sample is conditioned to only selective programs, the results change significantly. In the case of men, the positive effects on all engineering (civil engineering, electronics, industrial, mechanical and computer), education, accounting, and dentistry programs are preserved. In the case of dentistry, accounting and engineering, the magnitude of the effect is reduced. In engineering programs in particular, the effect declines to half of the effect found with the total sample or less. For both the total sample and the sample restricted to accredited programs, the effect of the public university on management program is negative. Finally, the effect on the economics, law, and medical programs is no longer statistically significant.

In the case of women, positive effects on engineering (civil, industrial, computer), education, accounting, dentistry and psychology programs are observed although, in the first case, the effect is not robust for the matching methods. The positive effects of public universities are magnified in education and civil engineering programs but are significantly reduced in

other cases. The exception is psychology which had a negative effect on the total sample. Unlike the total sample, the effects on law, nursing, and medical programs are not statistically significant with the $\hat{\tau}^{ATT}_{DM,BCM}$ estimator, and the effect on the economics and business administration programs turned out to be negative. Negative effects are also observed in medicine and law when considering only the PSM estimator bias correction.

The 20 best universities in Colombia

When the sample considered includes only programs in the 20 best universities in Colombia and only in the case of men, negative effects are observed for the law and medicine programs. At the same time, there is no effect on management and positive effects on the remaining programs. In the case of women, negative effects on law and positive effects on education, civil and industrial engineering, accounting, economics, and dentistry are observed. No effects on other programs are found.

In the case of men, positive and robust effects of public university on academic performance are found in accounting, computer engineering, mechanical engineering, industrial engineering, electrical engineering, and civil engineering programs. Likewise, the negative effect of public universities on the management program is robust for most of the cases considered except for the sample that includes only the best universities in the country. The effects on law, economics, and medical programs are not robust to different samples.

In the case of women, the effects are positive for most programs considered when the entire sample is included. However, the effect ceases to be positive in multiple programs when only accredited programs, selective programs, or the best universities in the country are included. There seems to be a strong positive effect on industrial and civil engineering, dentistry, and accounting programs in all samples except for the selective program sample. The effects on law, economics, medical, nursing, and psychology programs are not robust to the different samples considered in particular but are sensitive to the quality of programs considered.

b. Average Effect of private university

The differences between the people attending public universities, and those attending private universities make an evaluation of the effect of these types of institutions on their respective populations worthwhile. In the previous section, we assessed whether the people who attended public universities did better because they attended them, or if they would have done better if

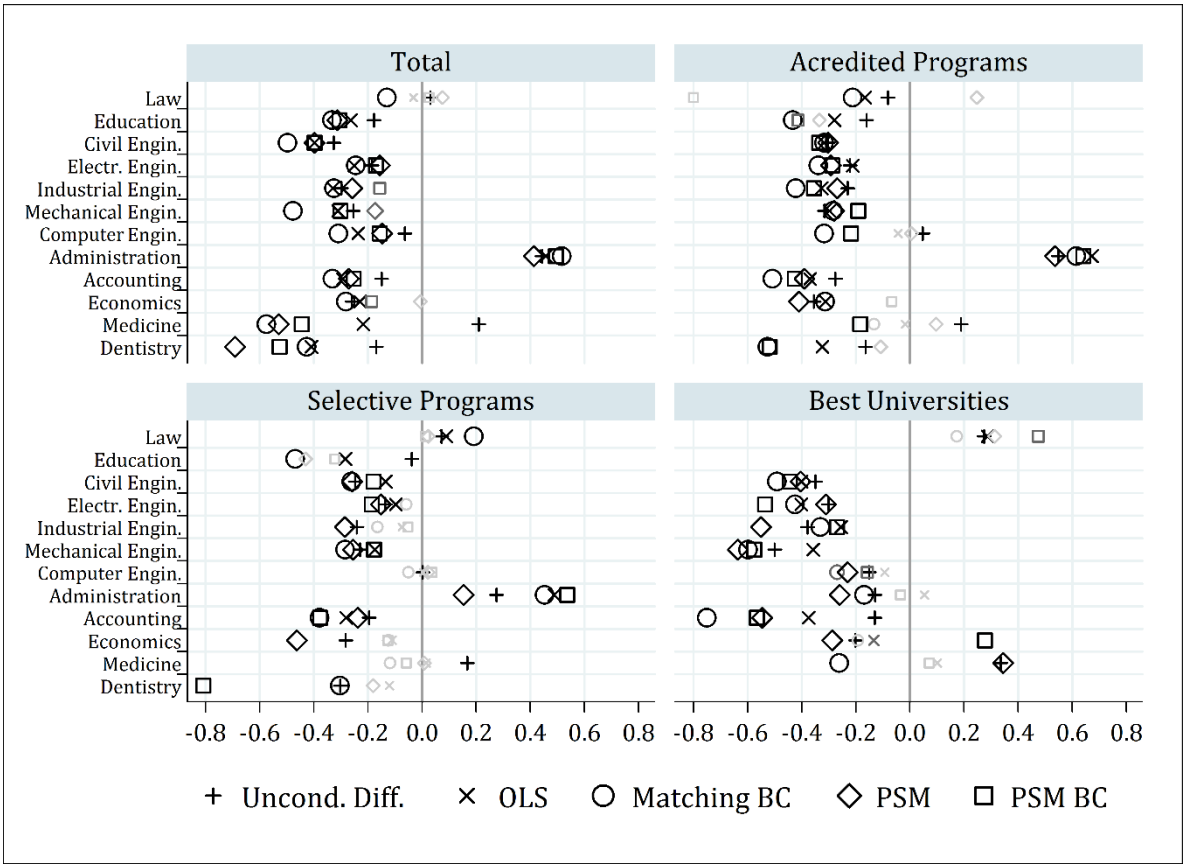
they had attended private ones. In this section, we evaluate whether the people who attended private universities did better because of that, or would have done better if they had attended public ones.

When attendance at a private university is considered the treatment of interest, the effects are generally inverse to those found in the case of public universities. This means the effects are negative and heterogeneous regarding the quality of academic programs (see figures 3 and 4). However, some important differences can be seen. First, with respect to the sample that considers all individuals, a private university has no statistically significant effect on the psychology program, while the public university showed a negative effect. Second, for the sample that includes only accredited programs[38], a private university has a negative effect on the medical program, while a public university has no statistically significant effect.

Finally, when considering only selective programs, several interesting results are observed: (i) in the case of men, private universities have a positive effect on law (0.19 SD) while the effect of public education was not statistically significant; (ii) in the case of men, private universities have no statistically significant effect on three engineering programs (electrical, industrial, and computer) which public universities had a positive effect on; (iii) in the case of women, private universities have no significant effect on industrial engineering, and (iv) negative effects are observed in the nursing (-0.28 SD) and economics (-0.29 DE) programs while public universities did not show significant effects on the former, and showed negative effects on the latter.

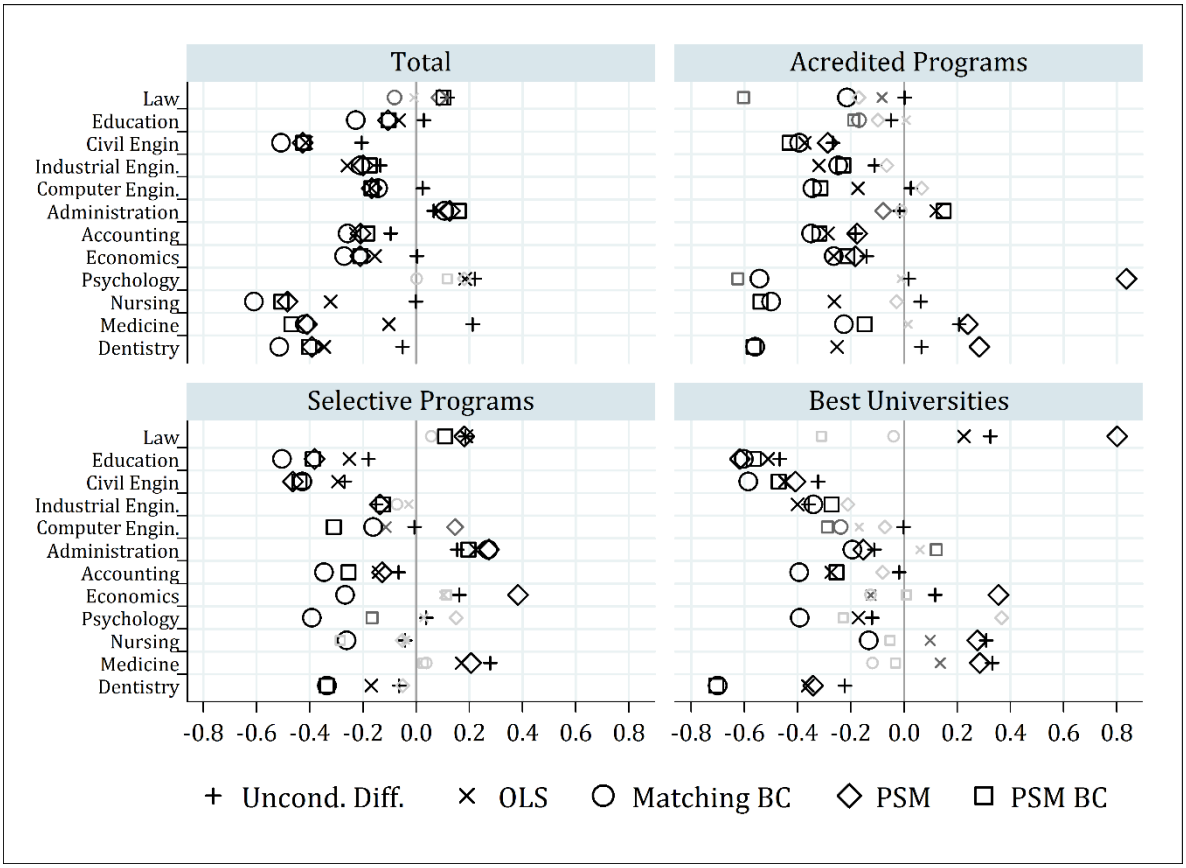
[38] Note the importance of controlling by the covariate bias associated with the matching method for the psychology program in the accredited program sample. In this case, the bias is so large that the effect goes from being positive without controlling for bias in PSM to negative when corrected for the bias associated with the covariates.

Figure 3 Treatment Results: Private, men



Note: The chart shows the results for men in four groups: Total, Accredited Programs, Selective Programs and Best Institutions. Each figure represents a different type of comparison. Thus, **crosses** show the average unconditional difference between private and public universities in each program. The **x's** show OLS exercise controlling for covariates. The **circles** show the Matching exercise with bias correction, and **diamonds** and **squares** show profit for the year using Propensity Score Matching and without bias correction respectively. The intensity of the color and size of the figures are related to the significance of the underlying exercise as well. A small, light gray figure involves no statistical significance. A gray intermediate size indicates a 10% significance, and a large, black figure indicates a 5% significance.

Figure 4 Treatment Results: Private, women



Note: The chart shows the results for women in four groups: Total, Accredited Programs, Selective Programs and Best Institutions. Each figure represents a different type of comparison. Thus, **crosses** show the average unconditional difference between private and public universities in each program. The **x's** show OLS exercise controlling for covariates. The **circles** show the Matching exercise with bias correction, and **diamonds** and **squares** show profit for the year using Propensity Score Matching and without bias correction respectively. The intensity of the color and size of the figures are related to the significance of the underlying exercise as well. A small, light gray figure involves no statistical significance. A gray intermediate size indicates a 10% significance, and a large, black figure indicates a 5% significance.

VI. Conclusions

The results for the total sample that includes all programs show that public HEI allow male and female students to get better scores in 11 of the 12 programs tested. The positive effects of public universities are robust to different samples analyzed in engineering programs for both men and women. It should be noted that in the case of men, much of the effect in engineering, despite being positive, declines once only the most selective programs are considered. In

addition, positive and robust effects for both men and women in the fields of education, accounting, and dentistry programs are observed.

For the sample of men, the negative effect of public universities on management is robust for all the cases considered. However, the effects on law, economics, medicine, nursing, and psychology, are not robust across the different samples considered, and in particular, they are sensitive to samples that are conditioned to program quality. In the case of the economics and psychology programs, the effect is ambiguous for the different samples analyzed.

Most of the results obtained in the case of public higher educational institutions are consistent when the treatment of interest is defined as attending a private HEI. In general, the effects are very much the opposite of those found in the case of public HIEs. However, some important differences are observed. First, when the total sample is used, private HEIs have no statistically significant effect on the psychology program for male or female students. Second, when the sample was restricted to the most selective programs in the case of men, private HEIs have a positive effect on law, and have no significant effect on electrical or industrial engineering, nor on computer engineering. Finally, when the sample was restricted to selective programs in the case of women, negative effects are observed on nursing and economics, and no effects were found on industrial engineering.

The overwhelming aggregate superiority of public HEIs versus private ones, suggests the need to promote greater regulation of the latter, review their current standards, and possibly, the accreditation status some of them hold to help bridge the gap that currently exists in terms of the value added public HEIs have in comparison to private ones. It also suggests that, at least in the short run, it could be profitable to expand the public provision of some of the higher education public programs that added more value than their private alternatives did.

It is important however, to note that no cost-effectiveness estimates were presented since only the benefit of studying at a public versus private HEI was estimated. Their relative cost was not included given that it would have required us to have information on costs for each institution which we did not have access to.

VII. References

Abadie, Alberto and Imbens, Guido (2011) "Bias-Corrected Matching Estimators for Average Treatment Effects" *Journal of Business and Economic Statistics*, Vol. 29, No. 1.

Abadie, Alberto and Imbens, Guido (2006) "Large Sample Properties of Matching Estimators for Average Treatment Effects" *Econometrica*, 74 (1), 235–267.

Abadie, Alberto; Drukker, David; Leber, Janee; and Imbens, Guido W. (2004) "Implementing matching estimators for average treatment effects in Stata" *Stata Journal*, StataCorp LP, vol. 4(3), pages 290-311, September.

Angrist, J., Bettinger, E, Bloom, E., Kremer, M., and King, E. (2002). "Vouchers for private schooling in Colombia: Evidence from a randomized natural experiment." American Economic Review 92 (5): 1535-1558.

Angrist, Joshua, Bettinger, E, and Kremer, M. (2006). "Long-term educational consequences of secondary school vouchers: evidence from administrative records in Colombia." American Economic Review 96 (3): 847-862.

Arango, Luis; Posada, Carlos E., and Uribe, José Darío (2004) "Cambios en la Estructura de los Salarios Urbanos en Colombia (1984-2000)"*Borradores de Economía*, No. 247, julio.

Attanasio, Orazio; Goldberg, Pinelopi K. and Pavcnik, Nina (2003) "Trade Reforms and Wage Inequality in Colombia" *NBER WP* 9830, July.

Attanasio, O., Kugler, A. & Meghir, C. (2011). "Subsidizing Vocational Training for Disadvantaged Youth in Colombia: Evidence from a Randomized Trial" American Economic Journal: Applied Economics 3, (July): 188–220.

Attanasio, O., Guarín, A., Medina, C., & Meghir, C. (forthcoming). Vocational Training for Disadvantaged Youth in Colombia: A Long Term Follow Up. American Economic Journal: Applied Economics.

Balcázar, Carlos Felipe and Ñopo, Hugo (2015) "Broken Gears: The Value Added of Higher Education on Teachers' Academic Achievement" *Institute for the Study of Labor (IZA) Discussion Papers* number 8477.

Banco Mundial (2003) "Tertiary Education in Colombia: Paving the Way for Reform" *Banco Mundial*, Washington D.C.

Barr, Nicholas (2009) "Financing Higher Education: Lessons from Economic Theory and Reform in England" LSE Research Online Documents on Economics 30873, London School of Economics and Political Science, LSE Library.

Bellei, C. (2007) "Expansión de la educación privada y mejoramiento de la educación en Chile. Evaluación a partir de la evidencia" Expansion of private schools and educational improvement in Chile. An evidence-based evaluation. *Revista pensamiento educativo*, 40(1), 1.

Bernal, Raquel and Peña, Ximena (2011) "Guía Práctica para la Evaluación de Impacto" CEDE - Universidad de los Andes.

Bettinger, E Kremer, M., and Saavedra, J. (2010). "Are Educational Vouchers Only Redistributive?" The Economic Journal 120(546): F204-F228.

Betttinger, E., Kremer, M., Kugler, M., Medina, C., Posso, C., y Saavedra, J. (2016). Can Educational Voucher Programs Pay for Themselves?. Working Paper.

Black, Dan; Daniel, Kermit and Smith, Jeffrey (2005) "College Quality and Wages in the United States" German Economic Review 6(3): 415-443.

Brewer, Dominic J.; Eide, Eric R. and Ehrenberg, Ronald G. (1999) "Does It Pay to Attend an Elite Private College? Cross-Cohort Evidence on the Effects of College Type on Earnings" *The Journal of Human Resources*, Vol. 34, No. 1 (Winter), pp. 104-123.

Caliendo, Marco and Kopeining, Sabine (2005) "Some Practical Guidance for the Implementation of Propensity Score Matching" *IZA DP* No. 1588.

Cárdenas, Mauricio and Bernal, Raquel (1999) "Changes in the Distribution of Income and the New Economic Model in Colombia" *Serie Reformas Económicas*, No. 36, Noviembre.

Cárdenas, Mauricio and Bernal, Raquel (2003) "Determinants of Labor Demand in Colombia: 1976-1996" *NBER WP* 10077, November.

Chetty, Raj; Friedman, John and Rockoff, Jonah (2014) "Measuring the Impacts of Teachers I: Evaluating Bias in Teacher Value-Added Estimates," *American Economic Review* Vol. 104(9), pages 2593-2632, September.

Chetty, Raj; Friedman, John and Rockoff, Jonah (2014) "Measuring the Impacts of Teachers II: Teacher Value-Added and Student Outcomes in Adulthood," *American Economic Review* Vol. 104(9), pages 2633-2679, September.

Cunha, J. and Miller, T. (2014) "Measuring value-added in higher education: Possibilities and limitations in the use of administrative data" *Economics of Education Review* Vol. 42 pages 64-77.

Del Bello, J. C. (2002) "Desafíos de la política de educación superior en America Latina: Reflexiones a partir del caso argentino con énfasis sobre la evaluación para el mejoramiento de la calidad" *LCSHD Paper Series*, 70, The World Bank.

Eide, Eric, Dominic J. Brewer, and Ronald G. Ehrenberg (1998) "Does It Pay to Attend an Elite Private College? Evidence on the Effects of Undergraduate College Quality on Graduate School Attendance?" *Economics of Education Review* 17(4).

Glomm, Gerhard and Ravikumar, B. (1992) "Public versus Private Investment in Human Capital Endogenous Growth and Income Inequality" *Journal of Political Economy* Vol. 100(4), pages 818-34, August.

Gomez, Norma (2015) "Three essays on human capital and labor markets for college graduates in Colombia" *Dissertation, Graduate Program in Agricultural, Environmental and Development Economics*, The Ohio State University.

Guarín, Arlen, Medina, Carlos and Posso, Christian (2016) "Calidad y Cobertura de la Educación Pública y Privada en Colombia, y sus Costos Ocultos" mimeo.

Hanushek, E.; Woessmann, L. and Zhang, L. (2011)"General Education, Vocational Education, and Labor-Market Outcomes over the Life-Cycle" *NBER Working Papers* No. 17504, National Bureau of Economic Research, Inc.

Hanushek, E (1992) "The trade-off between child quantity and quality" *Journal of Political Economy* 100, No.1 (February):84-117.

Hanushek, E (2002) "Publicly Provided Education" *NBER Working Paper* No. 8799, National Bureau of Economic Research, Inc.

Hanushek, Eric A. (2003) "The Failure of Input-Based Schooling Policies" *Economic Journal*, Royal Economic Society, vol. 113(485), pages F64-F98, February.

Heckman, J.; Ichimuray, H. and Todd, P. (1997) **"**Matching as an Econometric Evaluation Estimator: Evidence from Evaluating a Job Training Program**"** *Review of Economic Studies* 64, 605-654.

Hoxby, Caroline M. (2002) "Would School Choice Change the Teaching Profession?" *Journal of Human Resources*, Vol. 37, No. 4, pp. 846-891

Imbens, Guido (2004) "Nonparametric Estimation of Average Treatment Effects under Exogeneity: A Review" *Review of Economics and Statistics*, 86, 4–30.

Jaramillo, I. C. (2003) "La internacionalización de la Educación Superior y su Dinámica en Colombia" *The World Bank*. Latin American and the Caribbean Regional Office.

Kane, Thomas J. and Staiger, Douglas O. (2008) "Estimating Teacher Impacts on Student Achievement: An Experimental Evaluation." *NBER working papers* 14607, National Bureau of Economic Research, Inc. December.

Koretz, D. (2002) "Limitations in the use of achievement tests as measures of educators' productivity" In E. Hanushek, J. Heckman, and D. Neal (Eds.), Designing Incentives to Promote Human Capital. Special issue of *The Journal of Human Resources*, 37(4, Fall), 752-777.

Kugler, A., Kugler, M.. Saavedra, J., and Herrera L. (2015). "Long-term Direct and Spillover Effects of Job Training: Experimental Evidence from Colombia", NBER WP No. 21607 (October 2015).

López Hugo (2010) "El mercado laboral colombiano: tendencias de largo plazo y sugerencias de política" *Borradores de Economía*, Banco de la República, No. 606, Junio.

López, Hugo and Lasso, Francisco (2008) "Salario Mínimo, Salario Medio y Empleo Asalariado en Colombia" *Borradores de Economía*, Banco de la República, No. 484, Febrero.

Londoño, Juan Luis (1990) "Income Distribution during the Structural Transformation: Colombia 1938-1988" Tesis Ph.D., Cambridge, Harvard University.

McCaffrey, Daniel; Koretz, Daniel; Lockwood, J. R. and Hamilton, Laura S. (2004) "Evaluating Value-Added Models for Teacher Accountability" *RAND Corporation*.

Medina, Carlos and Posso, Christian (2010) "Technical Change and Polarization of the Labor Market: Evidence for Brazil, Colombia and Mexico" *Borradores de Economía* No. 614

Melguizo, Tatiana; Zamarro, Gema; Velasco, Tatiana y Sánchez, Fabio (2015) "How can we Accurately Measure whether Students are Gaining Relevant Outcomes in Higher Education?" *EDRE Working Paper* 2015-03.

Melo, Ligia & Ramos, Jorge and Hernández, Pedro (2014) "La Educación Superior en Colombia: Situación Actual y Análisis de Eficiencia" *Borradores de Economía* 808, Banco de la Republica de Colombia.

Núñez, Jairo and Sánchez, Fabio (1998) "Educación y Salarios Relativos en Colombia: 1976-1995. Determinantes, Evolución e Implicaciones para la Distribución del Ingreso" *Archivos de Economía*, No. 074, DDE-DNP, Bogotá, Enero.

OECD (2015) "Education at a Glance 2015: OECD Indicators" OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/eag-2015-en

OCDE and Banco Mundial (2012) "Evaluaciones de Políticas Nacionales de Educación: La Educación Superior en Colombia 2012" OCDE and Banco Mundial.

Posso, Christian (2008) "Desigualdad Salarial en Colombia 1984-2005: Cambios en la Composición del Mercado Laboral y Retornos a la Educación Post-Secundaria" *Borradores de Economía* No. 529, Banco de la República, Septiembre.

Rau, Tomás; Rojas, Eugenio and Urzúa, Sergio (2013) "Loans for Higher Education: Does the Dream Come True?" NBER Working Papers 19138, National Bureau of Economic Research, Inc.

Rivkin, S.G.; Hanushek, E. A. and Kain, J. F. (2005) "Teachers, Schools, and Academic Achievement" *Econometrica*, Vol. 73, Issue 2, páginas 417-458, Marzo.

Rosenbaum, P. R. and Rubin, D. B. (1983). "The central role of the propensity score in observational studies for causal effects". *Biometrika*, Vol. 70, páginas 41–55.

Rodríguez Revilla, R. (2015) "Medición del valor agregado para la educación superior en Bogotá" Tesis para optar al título de maestría en Economía, Universidad Santo Tomás.

Saavedra, Juan Esteban and Medina, Carlos (2012) "Formación para el Trabajo en Colombia" *Borradores de Economía* 740, Banco de la República de Colombia.

Saavedra, Anna R., and Saavedra, Juan Esteban (2011) "Do colleges cultivate critical thinking, problem solving, writing and interpersonal skills?" *Economics of Education Review* 30 (2011) 1516–1526.

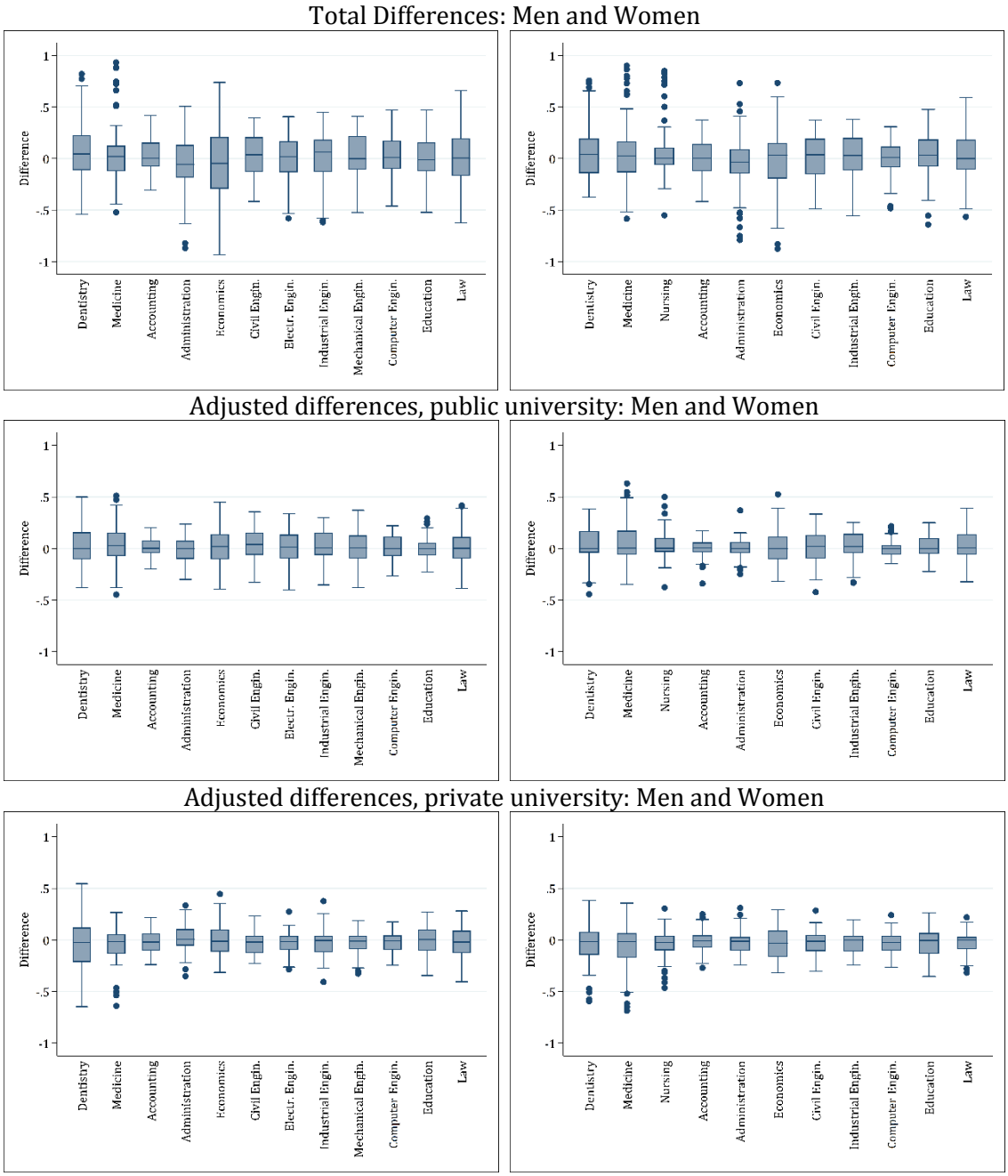
Sánchez, Fabio; Fernández, Camila and Jaime, Haider (2008) "Consultoría para Medir el Impacto del Crédito Educativo sobre el Acceso con Equidad y Permanencia en el Sistema de Educación Superior" Informe Final de Resultados, Centro de Estudios Sobre Desarrollo Económico, Facultad de Economía, Universidad de los Andes, Bogotá, D.C. 23 de junio.

Santamaría, Mauricio (2004) "Income Inequality, Skills and Trade: Evidence from Colombia during the 80s and 90s" *Documento Cede* 2004-02, February.

Winkler, D. R. (1994) "La educación superior en América Latina: cuestiones sobre eficiencia y equidad" *Documentos para Discusión* No. 77, Banco Mundial.

Appendix 1

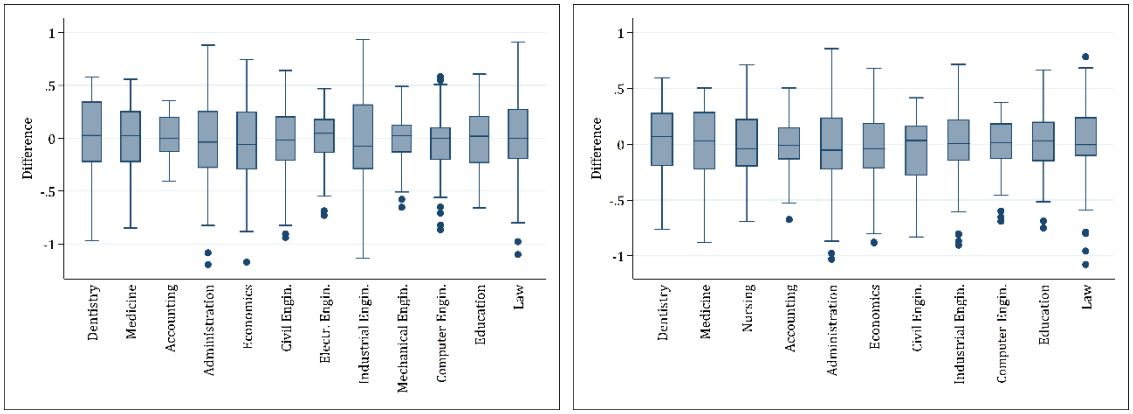
Figure A.1.1. Covariate Balancing Test



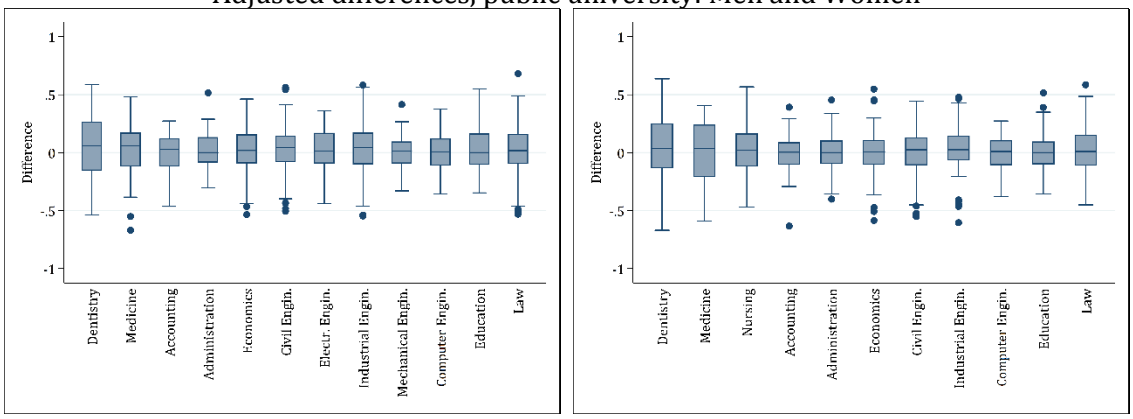
Note: the figure shows the standardized mean differences between public and private for the covariates used. The top panel shows the differences in the total sample. The middle panel shows the differences after the Matching with treatment = Public exercise was done and the lowest panel shows the differences after the Matching with treatment = Private exercise was done.

Figure A. 1.2. Covariate balancing test for the sample restricted to selective programs

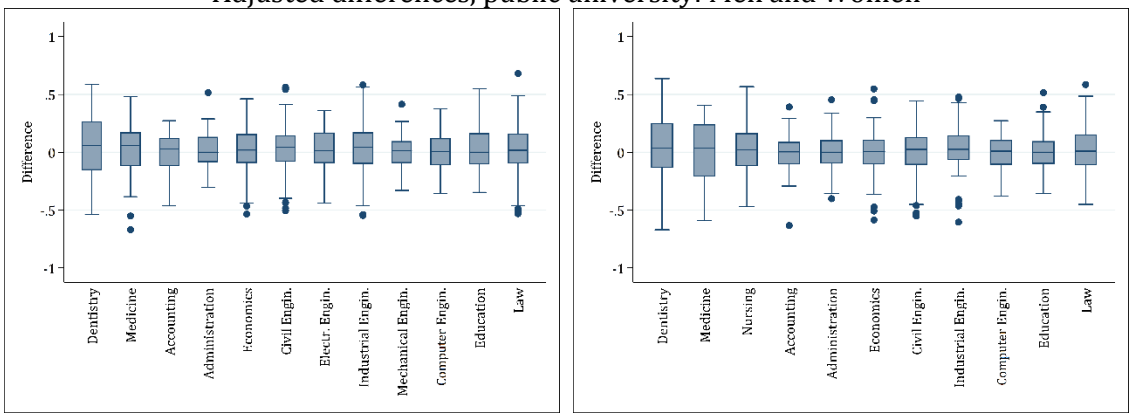
Total differences: Men and Women



Adjusted differences, public university: Men and Women



Adjusted differences, public university: Men and Women



Note: the figure shows the standardized mean differences between public and private for the covariates used. The top panel shows the differences in the total sample. The middle panel shows the differences after the Matching with treatment = Public exercise was done and the lowest panel shows the differences after the Matching with treatment = Private exercise was done.

Appendix 2. Definition of the control variables used in the matching estimators

Table A.2: Variables by category

Individual variables
Year of high school graduation
Gender
Reason why wants to study the selected program
Reason why wants to study in the selected HIE
Works
Age
ICFES score by field (Language, Mathematics, etc.)
Average ICFES score
Household variables
Number of persons in household
Home ownership
Household income
Socioeconomic stratum
Education level of mother
Education level of father
Mother's occupation
Father's occupation
Number of siblings attending higher education
Number of siblings in the household
Order among siblings
School variables
Type of school schedule (day/night)
Range of values paid for school tuition
High school calendar (A/B)
Character of school (Academic, *Normalista* or Vocational)
Nature of school (public/private)
School gender
Place where took the ICFES exam
4 main cities
13 main cities

Appendix 3. Common support, Propensity Score Matching Estimator

Program	Total			Acredited Programs			Selective Program			Best Universities		
Panel A. Women												
Dentistry	(0.007	-	0.965)	(0.021	-	0.968)	(0.035	-	0.986)	(0.069	-	0.986)
Medicine	(0.001	-	0.960)	(0.009	-	0.969)	(0.035	-	0.988)	(0.015	-	0.971)
Nursing	(0.011	-	0.998)	(0.016	-	0.991)	(0220	-	0.991)	(0.019	-	0.999)
Psychology	(0.006	-	0.975)	(0.002	-	0.746)	(0.003	-	0.997)	(0.008	-	0.922)
Economics	(0.006	-	0.993)	(0.008	-	0.995)	(0.021	-	0.984)	(0.021	-	0.950)
Accounting	(0.009	-	0.942)	(0.005	-	0.973)	(0.008	-	0.994)	(0.009	-	0.998)
Administration	(0.011	-	0.935)	(0.014	-	0.994)	(0.006	-	0.994)	(0.000	-	0.982)
Computer Engineering	(0.018	-	0.927)	(0.022	-	0.968)	(0.009	-	0.932)	(0.011	-	0.877)
Mechanical Engineering		NA			NA			NA			NA	
Industrial Engineering	(0.009	-	0.858)	(0.007	-	0.990)	(0.010	-	0.977)	(0.000	-	0.958)
Electrical and Electronic Engineering		NA			NA			NA			NA	
Civil Engineering	(0.014	-	0.930)	(0.017	-	0.932)	(0.060	-	0.967)	(0.072	-	0.955)
Education	(0.005	-	0.994)	(0.035	-	0.999)	(0.030	-	0.998)	(0.010	-	0.957)
Law	(0.001	-	0.931)	(0.001	-	0.815)	(0.008	-	0.992)	(0.005	-	0.965)
Panel B. Men												
Dentistry	(0.018	-	0.879)	(0.035	-	0.901)	(0.117	-	0.831)		NSC	
Medicine	(0.001	-	0.974)	(0.029	-	0.985)	(0.063	-	0.993)	(0.057		0.992)
Nursing		NA			NA			NA			NA	
Psychology		NA			NA			NA			NA	
Economics	(0.009	-	0.967)	(0.011	-	0.979)	(0.021	-	0.978)	(0.019	-	0.989)
Accounting	(0.013	-	0.918)	(0.011	-	0.984)	(0.043	-	0.980)	(0.019	-	0.955)
Administration	(0.015	-	0.943)	(0.021	-	0.984)	(0.006	-	0.990)	(0.002	-	0.997)
Computer Engineering	(0.006	-	0.968)	(0.015	-	0.982)	(0.023	-	0.979)	(0.020	-	0.969)
Mechanical Engineering	(0.007	-	0.921)	(0.030	-	0.990)	(0.028	-	0.931)	(0.004	-	0299)
Industrial Engineering	(0.006	-	0.936)	(0.009	-	0.958)	(0.003	-	0.978)	(0.005	-	0.925)
Electrical and Electronic Engineering	(0.012	-	0.957)	(0.006	-	0.970)	(0.013	-	0.955)	(0.021	-	0.957)
Civil Engineering	(0.041	-	0.968)	(0.014	-	0.995)	(0.023	-	0.997)	(0.034		0.987)
Education	(0.112	-	0.988)	(0.040	-	0.994)	(0.016	-	0.999)		NSC	
Law	(0.001	-	0.891)	(0.004	-	0.736)	(0.006	-	0.976)	(0.004		0.982)

Appendix 4. Summary Results of Matching Estimators

Gender	Program	Total							Acredited Programs							Selective Programs						
		Uncon. Differ.	OLS		Matching Treatment Public		Matching Treatment Private		Uncon. Differ.	OLS		Matching Treatment Public		Matching Treatment Private		Uncon. Differ.	OLS		Matching Treatment Public		Matching Treatment Private	
			Coef.	se	att	se	att	se		Coef.	se	att	se	att	se		Coef.	se	att	se	att	se
Men	Law	-0.03	0.03	0.03	0.26	0.04	-0.13	0.05	0.08	0.17	0.06	0.34	0.07	-0.21	0.08	-0.07	-0.09	0.05	0.07	0.06	0.19	0.07
	Education	0.18	0.26	0.05	0.31	0.06	-0.33	0.07	0.16	0.28	0.10	0.28	0.16	-0.43	0.14	0.04	0.28	0.09	0.39	0.10	-0.47	0.11
	Civil Engineering	0.33	0.40	0.04	0.59	0.05	-0.50	0.05	0.30	0.32	0.06	0.38	0.07	-0.32	0.07	0.25	0.13	0.06	0.21	0.07	-0.26	0.09
	Elect. Engineering	0.19	0.25	0.03	0.38	0.04	-0.24	0.05	0.22	0.21	0.05	0.39	0.07	-0.34	0.07	0.14	0.10	0.04	0.23	0.05	-0.06	0.06
	Industrial Engineering	0.30	0.33	0.03	0.47	0.05	-0.33	0.06	0.23	0.33	0.06	0.51	0.07	-0.42	0.08	0.24	0.07	0.06	0.17	0.08	-0.16	0.11
	Mechanical Engineering	0.25	0.31	0.04	0.47	0.06	-0.48	0.06	0.32	0.30	0.08	0.61	0.10	-0.28	0.13	0.23	0.17	0.06	0.30	0.07	-0.28	0.08
	Computer Engineering	0.06	0.24	0.03	0.43	0.04	-0.31	0.05	-0.05	0.04	0.05	0.14	0.07	-0.32	0.07	0.00	-0.01	0.04	0.13	0.06	-0.05	0.07
	Administration	-0.44	-0.46	0.02	-0.38	0.03	0.52	0.05	-0.55	-0.67	0.04	-0.63	0.06	0.61	0.07	-0.28	-0.49	0.04	-0.20	0.06	0.45	0.09
	Accounting	0.15	0.29	0.04	0.34	0.05	-0.33	0.06	0.28	0.37	0.07	0.50	0.09	-0.51	0.08	0.20	0.28	0.06	0.46	0.07	-0.38	0.08
	Economics	0.26	0.23	0.05	0.22	0.07	-0.28	0.09	0.35	0.31	0.08	0.50	0.09	-0.31	0.11	0.28	0.11	0.08	0.11	0.09	-0.12	0.11
	Medicine	-0.21	0.22	0.06	0.31	0.07	-0.58	0.07	-0.19	0.02	0.07	0.06	0.08	-0.13	0.08	-0.17	-0.01	0.07	-0.04	0.10	-0.12	0.09
	Dentistry	0.17	0.41	0.08	0.55	0.09	-0.43	0.09	0.16	0.32	0.12	0.58	0.13	-0.53	0.13	0.30	0.12	0.13	0.33	0.14	-0.30	0.12
Women	Law	-0.12	0.01	0.03	0.16	0.04	-0.08	0.04	0.00	0.08	0.05	0.25	0.06	-0.21	0.07	-0.20	-0.19	0.04	0.00	0.06	0.06	0.06
	Education	-0.03	0.06	0.02	0.20	0.03	-0.23	0.04	0.05	-0.01	0.06	0.19	0.07	-0.17	0.09	0.22	0.25	0.04	0.46	0.05	-0.50	0.07
	Civil Engineering	0.21	0.41	0.06	0.60	0.07	-0.51	0.07	0.27	0.37	0.10	0.39	0.10	-0.39	0.11	0.21	0.29	0.09	0.48	0.10	-0.43	0.11
	Industrial Engineering	0.13	0.26	0.03	0.50	0.05	-0.21	0.06	0.11	0.32	0.05	0.58	0.07	-0.25	0.09	0.17	0.03	0.05	0.13	0.07	-0.07	0.09
	Computer Engineering	-0.03	0.17	0.04	0.28	0.05	-0.14	0.05	-0.03	0.17	0.08	0.26	0.09	-0.34	0.09	-0.06	0.11	0.06	0.14	0.08	-0.16	0.08
	Administration	-0.07	-0.08	0.02	0.07	0.03	0.11	0.04	0.02	-0.12	0.04	0.06	0.05	-0.01	0.07	-0.01	-0.22	0.03	-0.11	0.05	0.27	0.06
	Accounting	0.10	0.23	0.03	0.32	0.03	-0.26	0.04	0.18	0.29	0.04	0.42	0.05	-0.35	0.06	0.14	0.14	0.04	0.35	0.05	-0.35	0.06
	Economics	0.00	0.15	0.04	0.19	0.06	-0.27	0.07	0.14	0.26	0.07	0.39	0.08	-0.26	0.09	-0.01	-0.10	0.08	-0.23	0.08	-0.27	0.12
	Psychology	-0.22	-0.18	0.03	-0.10	0.04	0.00	0.05	-0.02	0.01	0.06	0.14	0.09	-0.54	0.09	0.02	-0.03	0.04	0.12	0.06	-0.39	0.10
	Nursing	0.00	0.32	0.03	0.51	0.04	-0.61	0.04	-0.06	0.26	0.04	0.45	0.07	-0.50	0.06	-0.18	0.04	0.05	0.02	0.09	-0.26	0.07
	Medicine	-0.21	0.10	0.05	0.25	0.07	-0.42	0.07	-0.21	-0.02	0.06	-0.05	0.11	-0.23	0.09	-0.24	-0.17	0.06	-0.01	0.10	0.04	0.09
	Dentistry	0.05	0.35	0.05	0.45	0.06	-0.51	0.07	-0.07	0.25	0.07	0.31	0.08	-0.56	0.10	0.12	0.17	0.06	0.32	0.08	-0.33	0.09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