Serie *Investigation*

ICT, INNOVATION IN THE CLASSROOM AND ITS IMPACT ON HIGHER EDUCATION

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Ph. D. Sergio Alejandro Rodríguez Jerez
(Editors)

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The accelerated progress of technology in society nowadays, means that the way of carrying out formative activities in the different fields of knowledge is constantly being rethought in order to obtain more efficient, effective and innovative methods. This avalanche of changes also invades the educational environment and forces society to pose a series of questions regarding all areas of teaching. This influence in the educational field is not only limited to the impact that the deve lopment of new applications and programs has on the teaching-learning process, but also to the impact that the incursion of new technologies, techniques and software has on the curriculum, since these modify the skills required for pro fessional practice.

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Content

Chapter 8

Factors that influence carreer choice in Colombia: industrial engineering as case study[1]

Juan Carlos Morales Piñero[2], José Daniel Ramírez[3], Nestor Orlando Cordero Saez[4]

Abstract

This paper analyzes the influence of the offer expansion on technical and technological careers, salary expectations, and college reputation in the decision to choose a professional career. The study focused on the Industrial Engineering program using secondary information on salaries, population, and number of enrollees. The analysis period covers the years 2007-2015. The main conclusions show that although there are no significant differences in the salaries of recent graduates of industrial engineering, those from more expensive universities tend to earn salaries significantly higher over time. Large investments, necessary to complete professional studies, make return rates much lower than for the rest of universities.

Keywords

Carreer choice, industrial engineering, salary expectations.

[1] Some of these results were presented as a paper in REES 2017 and published in Morales, Cordero & Ramírez (2017).

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1. Introduction

The transition from secondary to higher education brings with it a decision from adolescent students to determine their future occupation (Villada, López, Patiño, Ramírez, Jurado & Ossa, 2002). Given the psychological insecurity facing the student, this decision may be influenced by factors such as family beliefs, social reputation, salary expectations, etc. (Martin, Simmons & Yu, 2014, Taylor, 2007).

Carnasciali, Thompson & Thomas (2013) analyzed the influence of socializers, self-identified competence, and the influence of the media on the decision. They found that gender and parents' educational level significantly impact on the choice to become an engineer. Piñero (2015), in his research based on the theory of rational action, concludes that individual characteristics (social origin, sex, and, school history) are the main factor leading career choice. Specifically in the case of Bogotá, Pineda (2015), using a Multinomial Logit Model, concludes that this choice depends on gender, higher education of the student's mother, family income, Saber 11 results, and salary expectations.

When studying at a public college is not viable, the family's investment on the student's career must be taken into account, having previously gone through the uncertainty of whether it will be worth the investment or not.

Either tacitly or explicitly, in many cases the question of how long will it take to complete higher education before entering the labor market is latent. Specifically in the case of students with an inclination to Industrial Engineering, questions arise such as the following arise: Should one study a technical or professional career? Which university to select? Will it be worth the investment? In this research, the influence of the expansion of the offer of technical and technological careers, salary expectations, and college reputation on the choice of Industrial Engineering as a professional project is analyzed.

2. Methodology

Secondary information on salaries was obtained from the Labor Observatory (MEN, 2015). The District Planning Department (2014)

served as the source of population data, and the SNIES (MEN, 2015) for information on enrollees. The analysis covers the years 2007-2015.

The Ministry of National Education (MEN) through the SNIES generates the student population database. It is public and can be viewed through its website (see technical sheet in Table 1).

Table 1. Construction of the student population database

Database	Student population
Source	Ministry of National Education (MEN)
Attendant	National Information System for Higher Education (SNIES)
Location	snies.mineducacion.gov.co/
Format	Excel spreadsheet
Periodicity	Annual
Filters	None
Modifications	Add period according to year
Population	New students in professional programs for each institution of Higher Education in Colombia.

Source: own elaboration.

The Ministry of National Education (MEN) through the Labor Observatory also generates the database for alumni (see technical sheet in Table 2).

Table 2. Construction of alumni database

Database	Alumni
Source	Ministry of National Education (MEN)
Attendant	Labor Observatory for Higher Education
Location	www.graduadoscolombia.edu.co/
Format	Excel spreadsheet
Periodicity	Annual

Database	Alumni
Filters	The following filters were applied in the portal of the entity in charge: 1. Academic Formation: Industrial Engineering 2. Level of Studies: University 3. Year of Court: 2015 4. Measures: Graduates / Revenues
Modifications	Add period according to year
Population	Graduates from the Industrial Engineering program who contribute to the General Social Health System

Source: own elaboration.

The variables analyzed were: number of enrollees, type of institution, career, number of industrial engineering programs, university, value of enrollment, salary of the graduate, salary growth for years of experience, and employability rate.

The first step to analyze the factors associated with choosing Industrial Engineering was to assess the performance of technical and technological careers compared to professional degrees during the study period, to assess the trend in the preference of high school graduates.

The study focused on industrial engineering, and analyzed the average salary in current Colombian pesos (COP) comparing graduates from technical or technological careers and professionals. Salary was measured based on the average monthly salary reported for each year, and adjusted based on the years of experience.

Next, the analysis focused on the students enrolled in Industrial Engineering in the country's 51 private colleges, for which complete information was gathered. Universities were classified according to the cost of enrollment in Industrial Engineering, taking 2014 as year of reference. Universities were grouped according to a cluster analysis applied with SPSS software, categorizing 12 universities as expensive, 22 as intermediate, and 17 as low-cost.

The students' preference for these three types of universities was analyzed according to the amount of applicants, admitted, and enrolled in Industrial Engineering by university during the entire study period.

Based on the classification made, the salary growth rate of graduates since 2007 was analyzed, taking the salary for 2015 as reference. This was done in order to compare salary differences regarding the cost of enrollment for each college.

Finally, an economic analysis for Industrial Engineering as a carreer option was carried out over a period of 10 years, from the moment the student enrolled in the career until completing 5 years of working experience. The investment was calculated based on the value of the enrollment for the year 2014 and was adjusted annually assuming a year-on-year inflation rate of 5%. Income was computed from year 6 on the basis of the average salary of a graduate of the year 2014, adjusted with the inflation of the previous 5 years. The salary was adjusted annually from the seventh year according to the growth rate of the experience curve. Every year they were analyzed in current Colombian pesos (COP).

The Colombian Institute of Educational Credit and Technical Studies Abroad (ICETEX, 2017) charged the lowest rate on the market, which was 3.66% in 2014, and it was used as the discount rate. This rate only applies to students with very low purchasing power, which technically could only be applied to economic universities. However, this rate was applied to all cases to perform the study under equal conditions. Once the cash flows for each year were calculated, the net present value, and the internal return rate of investment for each university were calculated.

3. Results

According to the MNE, Colombian universities covered 48.9% of the total population of 2,857,885 students in the country in 2015. 60% of the population that accessed higher education in this period did so in private institutions (SNIES-MEN, 2016), and 26% of them were enrolled in engineering programs. According to the National Information System for Higher Education (SNIES-MEN, 2014), Bogotá is the city that houses the most college students in the country. 44,073 of them are enrolled in

Industrial Engineering programs, distributed in 33 education institutions registered in the MNE.

According to the SNIES-MEN (2014), 469,320 students enrolled in college programs in Colombia in 2000, increasing by 87% in 2012 with 878,135 applicants, while inscriptions in the areas of Engineering, Architecture, Urban Planning and related areas (which include Industrial Engineering) increased by 75%, going from 138,556 to 242,751. This indicates a lower growth rate than the general average, and a decrease in participation compared to other programs with higher increases. For example, Social Sciences saw an increase of 107%.

Data gathered by Correa from August 4, 2015, showed a different scenario on the deficit in Colombia with 15,000 professionals in engineering, calculating an increase to 93,000 by the year 2018. The main areas to face difficulties would be technology, systems, and innovation, which is a great challenge for higher education institutions. As indicated by the president of the Colombian Association of Faculties of Engineering (ACOFI), the deficit of engineers in the country is concerning, as well as the training offered, since their quality does not meet the needs of the labor market (Velásquez, August 4, 2016). Table 3 shows the graduation rate by area of knowledge.

Table 3. Graduation rate 2015 by area of knowledge

Area of knowledge	College
Agronomy, veterinary, and others	24,20%
Fine arts	37,82%
Education sciences	37,97%
Health Sciences	44,32%
Social and human sciences	33,71%
Economy, administration, accounting, etc.	36,43%
Engineering, architecture, urban planning, etc.	29,18%
Mathematics, and natural sciences	26,25%

Source: SNIES-MEN, 2016.

3.1. Studies on the choice of engineering in Colombia

Choosing a college degree is not an easy process for students, and even more so in Engineering programs, where according to a study conducted in Colombia by Serna & Serna (2013), only 6.5% of young people in grade 11 considered studying Engineering. They also consulted college students in Engineering programs, and 54% of the population in fourth semester said they were comfortable with their career, decreasing to 44% among students in the seventh semester. These results contrast with other programs whose satisfaction rate is considerably higher, such as Business (85%), Law (90%), Accounting (91%), Mass Communication (92%), Psychology (93%), and others (78 %). The consultation of students who had transferred to other careers showed that 48.6% came from engineering careers. As a whole, these figures are aligned with the information from the MNE (MEN), which states that engineering programs have one of the lowest graduation rates among the areas of knowledge with 29.18% for 2015.

Studies conducted in Bogotá divide the factors that affect career choice in young people into four categories: individual, socioeconomic, academic, and motivational (Pineda, 2015). These categories include socio-economic factors (age, gender, marital status, social stratum, parent education, family income), school of origin, state tests results, and motivational aspects. The study states that if a student has high salary expectations, high family income, and good grades in basic sciences, they are more likely to choose engineering as a career.

González (2009) applied a multinomial logit model on a sample of 1025 first-semester students during periods 2006-1, 2006-2 and 2007-1 at the Pontificia Universidad Javeriana de Cali to analyze the reduction of engineering enrollment. Good results in mathematics, and the self-perception of academic success increase the probability of choosing engineer as a carreer. The author notes that it's mostly men who choose these careers, and that it is usually suggested by the father.

Serna & Serna (2013), when consulting the factors that influenced career choice in more than 1500 11th grade students, found the following as main motivators: the prospect offered by the program (33.9%), college

(18.6%), career recommendations (15.6%), advertising (8%), costs (3.2%), among other reasons (20.8%) (see Table 4). Three of them (university, recommendation, and publicity) are related to the image people have about the program and the institution, leaving the costs of the program in 5th place. Prospect is considered difficult to measure, since approximately 5 years will go by from the time a student chooses a career and the time they will enter the labor market. Even so, other factors can be taken into account regarding a program's projection over time, such as employability rates, the economic sectors in which the graduates locate, salaries, among others.

Table 4. Variables in carreer choice

Variable	Amount	Participation
Future	522	33,9%
College	287	18,6%
Recommendation	241	15,6%
Adverstising	123	8,0%
Costs	49	3,2%
Previous knowledge	45	2,9%
Professional counseling	36	2,3%
Few mathematics	35	2,3%
Faculty visit	34	2,2%
Previous experience	31	2,0%
Fair	29	1,9%
Psychological counseling	23	1,5%
Others	87	5,6%

Source: Serna & Serna, (2013, p 3). Own translation.

Regarding permanence, 70% of students who start engineering programs drop out, representing one of the highest dropout rates. Serna & Serna (2013) consulted 853 fourth-semester students, and 699 seventh-

semester students to know the reasons why engineering programs have such high desertion levels. When asking the first group how pleased they were with the career they chose, 54% of engineering students gave a favorable response, meaning that about half of the program's population has some type of nonconformity. The students who responded negatively were asked about the reasons why. Results are shown in Table 5.

Table 5. Reasons for engineering students' discomformity

Variable	Participation
Professors	17%
Does not fulfil the offer	16%
College	15%
Does not meet expectations	13%
Methodology	8%
Little practice	7%
Mathematics	5%
Out of reality	5%
Profile	4%
Too demanding	4%
Non-related content	3%
Disarticulation with the industry	3%

Source: Serna & Serna (2013, p. 9). Own translation.

3.2. Factors associated with the choice of Industrial Engineering

The first step to carry out the study was to evaluate the evolution of access to higher education in Colombia. The student population enrolled in universities, and technical and technological careers in the 2007-2015 period was calculated. This population was contrasted with the total amount of people in the country between the ages of 17 and 21, which is the usual age at which people enter higher education (see Table 6).

Table 6. Higher education coverage in Colombia

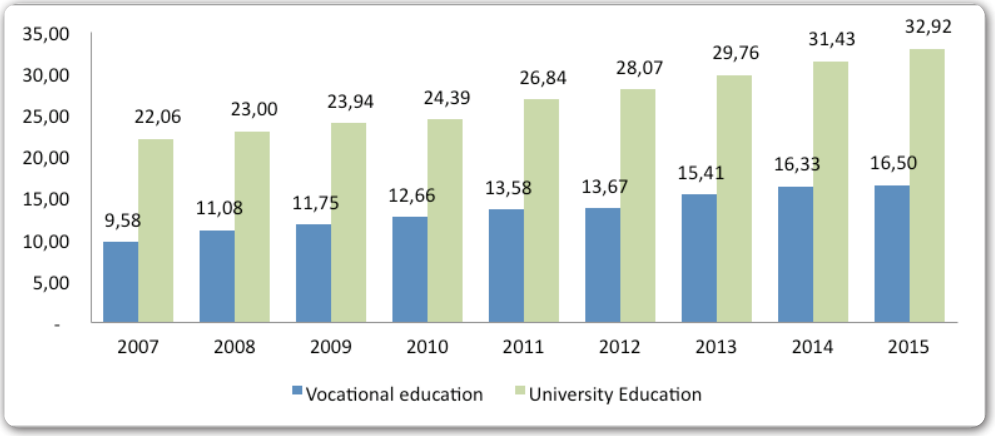
Year	Enrolled per year		Total enrolled by year	Population between 17 and 21 years of age	Coverage rate
	Technical and Technological carreers	College education			
2007	395.437	910.228	1.305.665	4.125.881	31,65%
2008	463.980	963.167	1.427.147	4.187.317	34,08%
2009	498.382	1.015.608	1.513.990	4.241.585	35,69%
2010	542.627	1.045.133	1.587.760	4.284.916	37,05%
2011	586.471	1.159.512	1.745.983	4.319.415	40,42%
2012	593.684	1.218.816	1.812.500	4.342.603	41,74%
2013	670.930	1.296.123	1.967.053	4.354.649	45,17%
2014	711.291	1.369.149	2.080.440	4.356.453	47,76%
2015	717.521	1.431.983	2.149.504	4.349.823	49,42%

Source: MEN, (2015).

The coverage rate for higher education in Colombia was calculated, differentiating vocational education from higher education. Results indicate that college remains as the main option over time for those who opt for higher education (Figure 1).

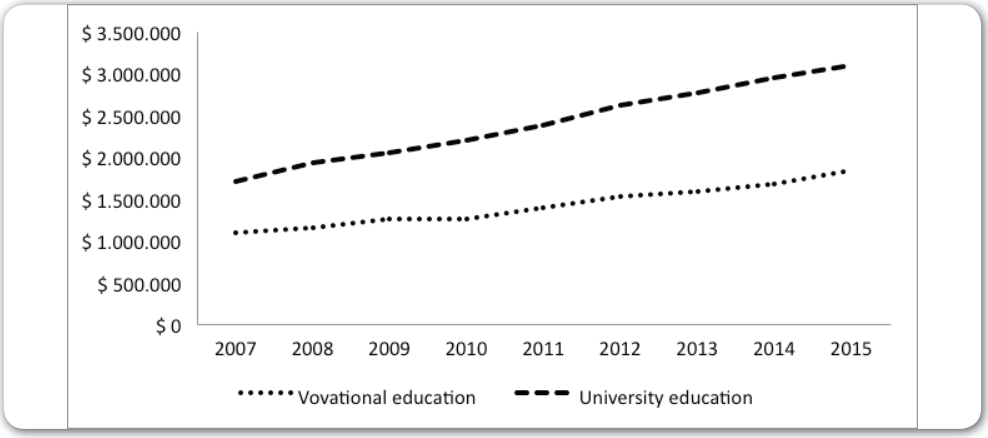
The evolution of average salaries of graduates in technical and technological careers, and in universities in areas related to industrial engineering was analyzed during the study period (see Figure 2). Not only is college graduates' salary higher than that those in technical careers, but their benefits tend to increase in a greater proportion over time. This can discourage the preference for technical and technological careers.

Figure 1. Coverage rate by type of institution



Source: own elaboration.

Figure 2. Salary of the recent graduate in COP



Source: own elaboration.

Once the differences between technical and college graduates was analyzed, the focus was on evaluating market behavior on the segment inclined to study Industrial Engineering in private universities in Colombia. A cluster analysis was initially carried out to classify the universities according to the value of enrollment for the year 2014 (see Table 7).

Table 7. Cost of the Industrial Engineering degree by type of university

Clúster Number	Descriptive	Tuition fee in 2014	Average wage in 2014
More Expensives	Mean	7.064.476	2.033.856
	Standard deviation	2.302.656	290.245
	N	12	12
	Minimum	5.057.350	1.573.126
	Maximum	13.144.000	2.419.651
Intermediates	Mean	3.788.760	1.698.348
	Standard deviation	470.704	267.856
	N	22	22
	Minimum	3.184.000	1.300.667
	Maximum	4.780.000	2.440.914
Cheapest	Mean	2.479.698	1.766.226
	Standard deviation	348.473	288.684
	N	17	17
	Minimum	1.599.950	1.205.750
	Maximum	2.910.000	2.147.820

Source: own elaboration.

Data from most expensive universities is the one with greater dispersion, since its standard deviation represents more than a third of the average. Once the classification was made, the evolution of those interested in Industrial Engineering in each type of university was analyzed, separating the process in phases. It is important to note that in Colombia, for an applicant to study at a university, they must submit their application to be evaluated by exams and/or interviews. Then, students are informed whether they have been admitted or not. Not all those admitted actually enroll, given it is common for students to apply to several universities.

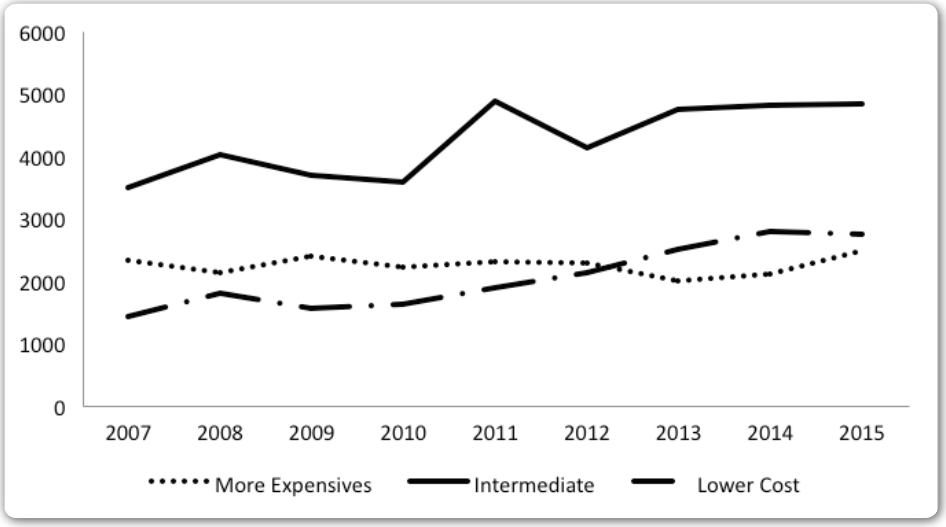
Table 8. Number of applicants for Industrial Engineering by type of process

University	Students by process	2007	2008	2009	2010	2011	2012	2013	2014	2015
More Expensives	Students who applied	4924	5169	5458	4877	5276	5598	5495	5465	6385
	Acknowledged Students	3014	3632	3747	3180	3947	4047	4174	4174	4473
	Enrolled Students	2320	2126	2384	2209	2290	2289	1995	2106	2476
Intermediate	Students who appliedx	4482	6218	6014	6091	6968	7247	9082	8601	8487
	Acknowledged Students	3742	5170	4688	4619	5872	5179	6054	6133	6620
	Enrolled Students	3483	4024	3694	3569	4873	4123	4733	4799	4836
Lower Cost	Students who applied	2070	1933	2648	2738	3428	3803	3707	4371	4202
	Acknowledged Students	1943	1659	2340	2354	2903	2871	3031	3309	3108
	Enrolled Students	1411	1800	1549	1608	1873	2114	2496	2782	2740

Source: own elaboration.

Figure 3 shows the evolution of the amount enrollees in Industrial Engineering during the study period, classifying colleges according to the cost of enrollment. Universities with an intermediate cost of enrollment gather the largest proportion of the market, and maintain a positive trend. Low-cost universities maintain a growing trend, and as of 2013 they began to attract more people than expensive universities. For their part, the most expensive universities have remained stable over time, managing between 2,000 and 2,500 students per year.

Figure 3. Students enrolled in Industrial Engineering by type of university



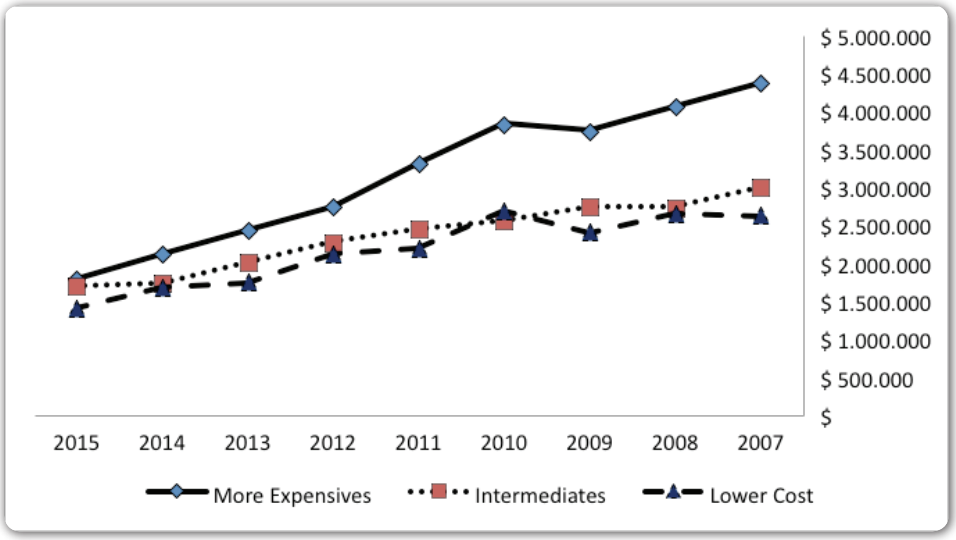
Source: own elaboration.

Average wages received by recent graduates in 2014 do not necessarily have a direct relationship with enrollment costs, nor is there a significant difference in the average salary of the recent graduate. This analysis was carried out during the study period, but comparing the average salary for the year 2015 (axis of the Y) regarding graduation year (axis of the X), to determine variations in salaries over time (see Figure 4).

Although there are no significant differences in the salaries of recent graduates, as time goes by, graduates from more expensive universities tend to earn significantly higher salaries than graduates from other universities. Meanwhile, graduates from colleges with intermediate or low-cost tuition tend to receive equivalent salaries as the years pass (Figure 4).

An economic analysis was made of the investment that a person must make in their career, in a 10-year timeline since the beginning of their studies in order to evaluate the economic scenario that an applicant of Industrial Engineering in Colombia has. The net present value of the investment and the internal return rate were calculated according to cash flows obtained (Table 9).

Figure 4. Salary of the Industrial Engineer in 2015 by year of graduation and type of university in COP



Source: own elaboration.

Although people who study industrial engineering in more expensive universities earn significantly higher salaries over time than the rest of the graduates, the high investment required imply very small return rates, even smaller than in other colleges. The gap would be much greater if a differentiated rate according to the market was applied, leading perhaps to discouraging studying at an expensive university taking economic reasons into considerations. The most cost-effective choice is offered by low-cost universities, since employability rates are equivalent in any of the universities.

Table 9. Salary expectation of an Industrial Engineer in Colombia

		Colleges by enrollment costs		
		Expensive	**Intermediate**	**Low-cost**
Average enrollment in COP (2014)		7.064.476	3.788.760	2.479.698
Enrollment costs*		12,07	6,15	4,02
Average wage in COP (2014) promedio en COP (2014)		2.033.856	1.698.348	1.766.226
Employability rate		87,51	84,03	82,27
NPV** in COP (10 years)		79.167.418	86.999.412	104.934.732
IRR *** in COP (10 years)		20,98%	30,98%	43,51%
Costo de la matrícula durante la carrera en COP	Año 1	-14.128.952	-7.577.520	-4.959.396
	Año 2	-14.835.399	-7.956.396	-5.207.366
	Año 3	-15.577.169	-8.354.216	-5.467.734
	Año 4	-16.356.028	-8.771.927	-5.741.121
	Año 5	-17.173.829	-9.210.523	-6.028.177
Ingresos del graduado en COP	Año 6	31.149.279	26.010.848	27.050.425
	Año 7	35.487.594	29.633.509	30.817.872
	Año 8	40.712.756	33.996.720	35.355.469
	Año 9	44.491.848	37.152.408	38.637.280
	Año 10	48.235.981	40.278.904	41.888.732

* In number of minimum wages in 2014; ** Net present value; *** Internal return rate

Source: own elaboration.

4. Conclusions

Results from this study show that although the number of students enrolled in technical and technological careers tends to grow proportionally to those enrolled in universities, the average salary received by university graduates tends to more significant increase overtime.

Universities with intermediate tuition are the largest proportion of the market, and maintain a growing trend throughout the study.

Although there are no significant differences in the salaries of recent industrial engineering graduates, overtime, alumni from more expensive universities tend to earn significantly higher salaries than those from other institutions. Even so, given the high investment involved in their studies, return rates are much lower than those from other academic institutions.

References

Carnasciali, M. I., Thompson, A. E., y Thomas, T. J. (2013). Factors in fluencing students' choice of engineering major. *ASEE Annual Conference and Exposition, Conference Proceedings* (p. 36).

Correa, T. (4 de agosto de 2015). Preocupante déficit de ingenieros en Colombia. *El tiempo*. Recuperado de http://www.eltiempo.com/archivo/documento/CMS-16402298

González G., D. E. (2009). Factores individuales que afectan la demanda de educación superior en ingenierías: caso de la Pontificia Universidad Javeriana de Cali. *Cuadernos de Administración*, *22*(39), 307-333. Recuperado de http://www.redalyc.org/pdf/205/20511993014.pdf

Instituto colombiano de crédito educativo y estudios técnicos en el exterior-[ICETEX]. (2017). Crédito a largo plazo - 0%. Recuperado de https://www.icetex.gov.co/dnnpro5/es-co/créditoeducativo/pregrado/cortoplazo100porciento.aspx

Martin, J. P., Simmons, D. R., y Yu, S. L. (2014). Family roles in engineering undergraduates' academic and career choices: Does parental educational attainment matter. *International Journal of Engineering Education, 30*(1).

Morales, J. C., Cordero, N. O., y Ramírez, J. D. (2017). Influence of economic expectation on choosing a university: a case study in Industrial Engineering. *Espacios, 38*(35), 1-10.

Observatorio Laboral. (2015). *Consultas Avanzadas - liferay.com*. Recuperado de http:// bi.mineducacion.gov.co:8380 / eportal / web /men-observatorio-laboral/consultas-avanzadas

Pineda, L. A. (2015). Factores que afectan la elección de carrera: caso Bogotá. *Vniversitas Económica, 15*(3), 1-35.

Piñero, S. L. (2015). Factores asociados a la selección de carrera: una aproximación desde la Teoría de la Acción Racional. *Revista de Investigación Educativa, 20*, 72-99.

Secretaría Distrital de Planeación. (2014). *Proyecciones de población por localidad para Bogotá 2016-2020* [Proyecciones de población]. Bogotá.

Serna, E., y Serna, A. (2013). *La formación en ingeniería en Colombia: una situación que preocupa*. Bogota. Recuperado de http://www.universidad.edu.co/images/cmlopera/descargables/formacioningenieria.pdf

SNIES-MEN. (2014). *Inscritos en educación superior Colombia 2000-2013*. Recuperado de http:// www.mineducacion.gov.co / sistemasdeinformacion / 1735 / articles-212400_Inscrito.zip

SNIES-MEN. (2015). *Sistemas de información*. Recuperado de http://www.mineducacion.gov.co/sistemasdeinformacion/1735/w3-article-212400.html

SNIES-MEN. (2016). *Matriculados en Educación Superior- Colombia 2015*. Recuperado de http://www.mineducacion.gov.co/sistemasdeinformacion/1735/articles-212400_recurso_15.zip

Taylor, D. (2007). Employment Preferences and Salary Expectations of Students in Science and Engineering. *BioScience*. Recuperado de http://doi.org/10.1641/B570212

Velásquez, L. (04 de agosto de 2016). En Colombia se necesitan 18.000 ingenieros más. *El Colombiano*. Recuperado de: http://www.elcolombiano.com / colombia / educacion /en-colombia-se - necesitan- 18-000-ingenieros-mas-JM3970856

Villada, C. A., Lopez, L. M., Patiño, C. D., Ramirez, W., Jurado, C. M., y Ossa, J. (2002). Factores asociados a la elección de carrera y universidad. *Unipluriversidad, 2*(2), 23-30.