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The education of economists in Colombia: Quality differences and its determinants

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The Education of Economists in Colombia: Quality Differences and its Determinants *

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Abstract

For the standardized Test of Higher Education Quality (ECAES) taken in 2007 by undergraduate economics students in Colombia, we apply the DiNardo, Fortin, and Lemieux (1996) decomposition technique to estimate what would be the distribution of scores for student in non-accredited programs if they had had the characteristics of students in accredited programs. In particular, we evaluate in which part of the distribution individual, family, program, and institutional characteristics, respectively, have their greatest impact. The score distributions indicate better performance by accredited economics programs compared to non-accredited programs. Results suggest that individual characteristics explain the larger part of the gap, while family features contribute least. The program and institutional characteristics have opposing impacts, mainly around the mean of the score distribution. There are unexplained differences in the production process that appear more efficient in the accredited programs.

Keywords: Academic Quality; Education of Economists; Higher Education; Colombia; ECAES; Kernel Density Estimation; Decomposition.
JEL-codes: A22, C14, I21, I23.

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Introduction

Traditionally, research regarding the quality of education has focused on primary and secondary education, levels for which international comparison is facilitated by the existence of standardized tests such as PISA. An extensive review of this recent literature by Hanushek and Woessmann (2011) highlights the importance of not only individual and family characteristics in the explanation of differences in educational achievement at pre-university level, but also of school characteristics and of institutional differences between countries. Specifically for developing countries, Glewwe and Kremer (2006) review the role of programs and systems in the quantity and quality of education obtained, also with a focus on primary and secondary education. For higher education, research on the determinants educational achievement and quality is much more limited. International comparison of educational programs is hindered by the absence of internationally standardized tests as they exist for the pre-university levels, although recently the OECD has started initiatives for an assessment of the outcomes of higher education (OECD, 2013). In practice, even research within one country is often similarly hampered by the lack of (nationwide) standardized tests; by implication, research into the quality of university programs is often restricted to students in one university or by comparisons based upon non-standardized measures such as the GPA. Hence, although many studies in the international literature have found a significant link between educational quality and students' individual and socio-demographic characteristics as well as with the program and institutional characteristics, the evidence is scarce both with regard to institutions that offer higher education as well as to developing countries.

In this paper we make use of a unique feature in the higher education system in Colombia that requires students in the last semester of their undergraduate programs to sit a standardized end-of-degree test. It provides a unique opportunity to investigate the factors that can explain differences in educational achievement for undergraduate students in a developing country.

Increased coverage and improvement of the quality of higher education are often considered a priority for the formation of human capital in a society (Bloom and Rosovsky, 2007), and analysis using aggregate data suggests a close relation between education and growth (Krueger and Lindahl, 2001; Cohen and Soto, 2007). The study of the determinants of quality differences in the education of economists in developing countries like Colombia is particularly relevant because it reflects the barriers for human capital acquisition at the time when young

adults are close to permanent entry to the labor force. Historically, governments have focused their efforts on expanding educational coverage. Recently, quality has gained importance in education policies and motivations of people to choose an institution of higher education in Colombia (Gamboa et al., 2003; Viloria De la Hoz, 2006), supported by the argument that cognitive skills are a more important contributive factor for economic growth than the quantity of education per se (Hanushek and Woessmann, 2008). As a result, the programs at the most prestigious institutions attract both faculty and students of high-quality. Nevertheless, relatively little is known about the factors that define a successful undergraduate program, knowledge that is even scarcer in developing countries such as Colombia.

In this paper we focus on undergraduate economics programs in Colombia. Our research question is whether all students of undergraduate economics programs in Colombia had the same opportunities to achieve a satisfactory academic performance. The paper is motivated by the idea that the "added value" of higher education to the students' development varies between programs, and our main contribution is to disaggregate the gap along the distribution of the students' outcomes and investigate the roles of the different groups of characteristics considered relevant in economic literature. In particular, we will distinguish between accredited and non-accredited programs, and analyze which factors can explain the difference between their undergraduate students' scores in the Test of Higher Education Quality (ECAES, for its abbreviation in Spanish), a standardized national exam that the students present in the last semesters of their undergraduate program. We have data from 2,219 undergraduate economics students that presented the 2007 ECAES, comprising almost 100% of the population.

To respond our research question, we use the decomposition technique developed by DiNardo et al. (1996) and in particular the stepwise decomposition strategy proposed and used by Altonji et al. (2012). This procedure permits us to analyze the effects of individual, family, program and institutional characteristics on the distribution of students' test scores. In contrast with the more traditional Oaxaca-Blinder decomposition that focuses on the mean of the distribution, the method of DiNardo et al. considers the whole test score distribution. The technique, based upon kernel density estimations of the (reweighted) test score distributions, is used to construct counterfactual distributions that mimic the scores that students with characteristics found in the accredited programs would have obtained if they had studied in the environment of the non-accredited programs. Through the comparison of counterfactuals created

with different sets of characteristics, we obtain information about the relevance of each group of characteristics on the difference between the distributions of the ECAES scores for accredited and non-accredited programs.

The distribution of the scores obtained in the 2007 ECAES by students from accredited programs lies to the right of the scores in non-accredited program, indicating better performance by accredited economics programs. Our results suggest that the individual characteristics, largely determined before entry to an undergraduate economics program, are the prime explanatory factor for the differences between accredited and non-accredited programs. Socio-economic differences captured by parental education and occupation, and the household's socio-economic status do not have additional explanatory power. The program features increase the mean score of the distribution; when the characteristics observed in accredited programs had applied, the students in non-accredited programs would have concentrated more around the mean. The institutional characteristics had influence in the opposite direction. Results suggest that there are different forms of production function of education in economics programs; economics programs with accreditation were more efficient in transforming the available inputs.

The following section reviews the literature about the education quality of economists at the undergraduate level for various countries, and terminates with a focus on the literature for the Colombian case. Section 3 presents the empirical strategy and gives a brief outline of the methodology proposed by DiNardo et al. (1996) and Altonji et al. (2012), while Section 4 introduces the data that we use. Section 5 presents the estimation results and robustness checks, and Section 6 discusses the implications and draws some conclusions.

1. Literature review

We give a brief overview of the relevant findings in the international literature regarding the determinants of the education quality (section 2.1). Given that our data for Colombia do not provide information regarding the labor market outcomes of the surveyed students, we focus on the school outcomes, while being aware that the ultimate goal of the education is the access to and insertion in the labor market. In section 2.2 we review the few studies available on the quality of higher education in Colombia.

1.1 International literature on the quality of education in economics

Education is the key component of individuals' development and the mechanism used to achieve their main objectives and future (Becker, 1993). Each new step in a student's educational career and their academic achievement are determinants of future economic accomplishments and other aspects such as the access to graduate programs or the social status they can achieve. The literature has given a prominent attention to the quality rather than equity (Becker, 2000). However, a lively discussion both regarding the measurement of the quality as well as its determinants has evolved, particularly when considering higher education.

1.1.1 Measurement of education quality

The debate about education quality is broad. Specifically, assessing the quality of economics programs is difficult because programs have many facets. One of the most valuable sources of information about a program is the students' performance in the program. Thus, a key measure in determining program quality is the quality of students (Perry, 1995). Standardized tests are frequently used in literature as quantifiable measures about quality of students; however, relatively few studies have been dedicated to quality in higher education, partly because standardized tests are less common. Indeed, in 2008 the OECD has launched the AHELO Feasibility Study to analyze the performance of higher education students with respect to generic and discipline-specific skills, doing a pilot test in 2012 with students of economics and engineering (OECD, 2013).

In the analysis of quality in higher education, it is relevant to consider the student's evaluation system that provides information on learning and levels of knowledge acquisition. Measures of students' quality such as the Grade Point Average (GPA) have been considered in the literature. For instance, Spenner et al. (2004) used the GPA as an academic performance measure of students at end of the first semester in their first college year for the classes who graduated in 2005 and 2006 from Duke University, while Betts and Darlene (1999) analyzed the college performance by GPA of students at the University of California. Simonite (2003) studied the quality of education as the GPA reached in three years for students who entered in the modular degree program at Oxford Brookes University in September 1994 and graduated with honors in July 1997.

The literature has also examined the academic achievement by looking at the grades in some particular courses. For instance, Krohn and O'Connor (2005) measured the performance of students in the agricultural economics program at the Bucknell University by the grades of students in three intermediate macroeconomics courses. Ziegert (2000) analyzed the grades in courses of microeconomics principles and the score reached on the Test of Understanding of College Economics (TUCE) at the end and the beginning of semester for a sample of students in Miami University.

An alternative measure of academic performance is the number of approved courses. Porto and Di Gresia (2004) and Porto et al. (2005) measured academic performance with the number of approved courses from economics students at the Universidad Nacional de la Plata in Argentina.

Furthermore, some studies have used placement in the job market as an alternative measure in assessing the educational quality of a particular program (Perry, 1995). Bright students will be attractive in the job market. Nevertheless, even departments that have deteriorated their training or that are not attracting bright students may still be able to rely on their past reputation to help place their students. Consequently, placement quality may not entirely reflect education quality.

Other studies used more than one measure of educational quality. Mattson (2007) studied the college impact on student's learning in the first year from University of Southern California with three different measures: college GPA; GRE scores in verbal, quantitative and composite; students' report of growth in verbal and quantitative courses.

Most studies consider particular cases; studies that analyze the education quality comparing the outcomes in more than one university are rather scarce. This is because of absence of comparable data for different universities. Among the few studies of education quality that make a comparison between universities, we encountered the analysis of Perry (1995), who measured the quality of graduate programs of 18 top institutions in United States by means of the Graduate Records Exam (GRE) and the Grade Point Average (GPA) from PhD students who were in their second or third year. However, it should be noted that GPA is not necessarily comparable between universities, given potential differences both in the contents of the courses and the marking of the exams; the same GPA may be the result of different underlying capacities, given that the exams are program (or even professor) specific.

1.1.2 Determinants of education quality

Numerous empirical studies have delved into the analysis of the factors that determine the quality and the outcome of the students' education. Factors that affected the quality of education can be grouped in four sets of characteristics (Vegas and Petrow, 2008; World Bank, 2008): (i) what does the student bring to the economics program, that is, the individual characteristics; (ii) social and family conditions of students; (iii) elements of the program or the campus such as the effectiveness of teachers and infrastructure characteristics; and (iv) institutional issues of the higher education system.

First, we review the findings in the literature regarding the individual undergraduate students' characteristics on the performance. A frequently analyzed factor is the gender difference in educational attainment of economics students. Some studies have found that women had better academic performance (Betts and Darlene, 1999; Simonite, 2003; Porto and Di Gresia, 2004; Mattson, 2007), while others have found that men did better (Anaya, 1999; Spenner et al., 2004; Krohn and O'Connor, 2005).

On the other hand, differences in performance at the university may reflect, at least in part, the knowledge acquired in high school. Anaya (1999), Ziegert (2000), Krohn and O'Connor (2005) and Mattson (2007) included prior academic achievement measured as high school GPA or SAT Verbal and Math scores.

In addition, another characteristic considered in literature has been age. In some studies younger students had better performance (Porto and Di Gresia, 2004), while in others older students scored better (Simonite, 2003). Also students that came from public secondary schools (Betts and Darlene, 1999; Porto and Di Gresia, 2004) or those who had a break in enrollment (Porto and Di Gresia, 2004) had a lower performance in university. Moreover, lower academic achievements were recorded for African-American students (Ziegert, 2000; Spenner et al., 2004).

The characteristics mentioned up to now are inherent to the individual, or at least predetermined, that is, set before entry in university. Other characteristics are, at least partly, governed by decisions while in university. For example, with regard to marital status, single students did better than married students (Anaya, 1999; Porto et al., 2005). For those who took fewer economics courses (Krohn and O'Connor, 2005) and for those who worked, even more when they worked more hours (Porto et al., 2005), the performance was lower. Anaya (1999)

and Krohn and O'Connor (2005) examined the relationship between student efforts (measured by hours spent on various course activities) and student performance. The literature also considers other variables as financial goals (Anaya, 1999) and aspirations (Anaya, 1999).

The second set of determinants in the analysis of the quality of education is formed by the socio-demographic status and family background of students. Also those are largely predetermined, and tell something about the potential intellectual and financial contributions in current and earlier stages in life. Variables included are the place of birth (Porto et al., 2005), place of residence (Porto et al., 2005), whether students live with their parents (Porto and Di Gresia, 2004), if they had parental participation in homework (Spenner et al., 2004), and more in general the level of education obtained by the parents (Anaya, 1999; Porto and Di Gresia, 2004; Simonite, 2003; Porto et al., 2005) and social class (Bratti, 2002; Simonite, 2003).

As a third group, the characteristics of program and institution are relevant for the differentiation of the student performance in universities. For individual students those characteristics are a given fact once enrolled a program, but before that they may be decisive for selecting a specific program. The first stage in the student-university relationship is the mechanism of entry or admission. Admission can occur in two ways, based on students' prior academic achievement or through conducting university-specific admission tests. In the case of Universidad Nacional de la Plata in Argentina the initial assessments did not reflect the future academic performance of students (Porto et al., 2005).

Another important factor is the quality of the academic program. Research output is often used as a measure of departmental quality. Perry (1995) mentioned two indicators of research output, publications and citation counts. Publications are useful in assessing the professional activity and competence. Citation counts help in assessing the long-term impact.

Also the perception of the students about the quality of education they have received is relevant to determine the quality of the program. By means of a student survey, Perry (1995) ranked the programs considering: quality of classroom instruction; rigor of classroom material; relationship with faculty; research opportunities; camaraderie among students; physical facilities; financial support; opportunities to participate in seminars and conferences; opportunities to write for journals; program administration; preliminary exams; breadth and depth of material covered in fields; and coursework availability. Other investigations incorporate more objective indicators of academic environment and nonacademic activities. Specifically, Anaya (1999) considered the

following activities: choice of electives, number of years lived on campus, participation in clubs and sports, hours per week for socializing with friends and for speaking with faculty outside of class.

Finally, with a broader spectrum, the organizational structure, the evaluation systems and salary schemes for professors in the countries influence the quality of education (Albán, 2005). Furthermore, Greene (1998) mentioned that regional differences in the education system were important for academic achievement.

1.2 Quality of higher education in Colombia

Post-secondary education in Colombia is offered by a heterogeneous set of institutions, highly differentiated by type, size, vocation and resources (Acosta, 2004). The numbers of programs and universities have grown considerably in recent decades, but coverage continues limited compared with international standards (Orozco, 2005). Despite of the increasing number of students enrolled in Colombia, coverage of higher education eligible population remained around 20% in 2002, compared with the Latin American average of 25% and the OECD country average of 54% (Orozco, 2005). Participation of women increased significantly, in 2006 women represented a little more than 50% of total enrolled students. There is an increasing dominance of the private sector regarding the number of students and institutions. The concentration of institutions and students in the nation's capital Bogotá is noticeable; despite regional expansion, institutions of higher education are concentrated in a few centers of development. Also, the level of education achieved by faculty remains low and the development of research and graduate programs has been limited, even in the most traditional institutions (Consejo Nacional de Acreditación, 2006).

Given the wide variety of institutions offering higher education programs, in Colombia, as in other countries, there has been a trend towards greater market orientation on the part of universities, highlighting the preferences of customers or direct users (students) and indirect stakeholders (employees), and the system has provided institutions incentives to improve the quality, innovation, academic productivity and services to society (Capelleras, 2001).

In response to the need to strengthen the quality of higher education, in 1982 the National Accreditation System was established (Consejo Nacional de Acreditación, 2013). Accreditation

is mainly concerned with how an institution and its programs must be geared towards an ideal of excellence and high quality, which can be displayed through specific outcomes, social impact and recognition (Consejo Nacional de Acreditación, 2013). Consejo Nacional de Acreditación (2013) presents the factors that are taken into consideration for the accreditation. In the accreditation process 1657 undergraduate programs were involved until 2012. Of those, 1439 programs, corresponding to 109 higher education institutions, had obtained accreditation; 218 programs had received confidential recommendations to improve its quality.

Despite the implementation of new policies aimed at the improvement of the quality of higher education programs, few studies have been devoted to assessing how these efforts of programs and institutions have been reflected in the learning and quality of education received by students. The study of Celis et al. (2012) is one of the few that attempts to compare separately the characteristics of students in high school and in university according to academic performance on standardized tests. Celis et al. examined the results of standardized tests that were performed at the end of high school for the period 2000-2004 and at the end of university programs for the period 2008-2009, applying multilevel hierarchical models to contrast individual, family and campus features in association with the scores obtained by the students. The results indicate that socioeconomic conditions and family background had the greatest explanatory power on the achievement obtained by the students in secondary education. However, in higher education the effect of the campus was more relevant (up to 50% of the total academic achievement). Unlike the secondary level, in higher education there are no significant differences in academic performance between students from public and private universities. In addition, the differences in higher education were mainly by campus features because socioeconomic conditions of students who ended the cycle of higher education were rather homogeneous.

For measuring differences in academic performance specifically for economics students, Valens (2007) and Ortiz (2005) analyzed the ECAES in economics for 2004; that was the first standardized test performed at the end of the last undergrad year to economics students in Colombia. Using multilevel analysis Valens (2007) found that there were significant differences between the mean scores of universities and among students. These differences were explained by personal characteristics of students and the characteristics of the institution at which they studied. Ortiz (2005) conducted a descriptive analysis of the ECAES in economics for 2004,

showing that most economics programs were characterized by low quality levels, being private universities the ones with the lower levels. Similarly, Ortiz found that the academic tradition was important because the traditional universities showed better performance in ECAES. Work and study at the same time presented a negative incidence in the quality of education; students in (full-time) day programs had better scores than students of the (part-time) evening programs.

Sarmiento and Sandoval (2008) examined the results obtained by students in the ECAES of economics 2004-2006. Through an analysis of covariance (ANCOVA) they found that the best scores were for day students and for those from accredited institutions. In addition, they highlight the limitations of this standardized test for the intertemporal analysis; the test does not allow the comparison of different time periods because the scores are normalized each period. Nevertheless, Gómez (2013) studied, by using propensity score matching but without mentioning how the problem of temporality was addressed, the scores in the ECAES test presented by economics students during the period 2004-2008 and the scores reached by students at the end of secondary education in 2000-2010. The results suggested that students of economics from Javeriana University must have had a better performance in ECAES than other students of economics with similar observable characteristics.

As is evident from the literature review, there are few studies that focus on the assessment of the quality of higher education, and we did not find any study on the characteristics of the distribution of quality of education among economics students and their programs.

2. Empirical strategy

Our aim is to analyze which factors can explain the differences in the standardized national economics exam results between last year undergraduate students from accredited and non-accredited economics programs. We propose to use the decomposition technique developed by DiNardo et al. (1996, hereafter DFL) and Altonji et al. (2012), a technique that analyzes the distribution of exam results and is not focused at the mean, as is the case for the traditional Oaxaca-Blinder decomposition (Oaxaca, 1973; Blinder, 1973).

The technique is based upon kernel estimates of the original densities of the exam results in non-accredited and accredited undergraduate economics programs, and compares these with

counterfactual distributions that mimic how students with characteristics that are found in the accredited programs would have fared in the environment of the non-accredited programs. Through successive expansion of the set of characteristics that enter the construction of the counterfactuals, we can see which characteristics are more relevant in explaining the differences between the distributions of the exam results in the two program types. This methodology permits that characteristics have different effects in different parts of the distribution.

2.1 Kernel estimation

The starting point for the DFL decomposition is the kernel density estimation of the distribution of the observed individual exam results $X_1, \ldots, X_n$ for the n students who participated in the exam in 2007, with respective sample weights $\theta_1, \ldots, \theta_n$.[1] The estimation $\hat{f}_h(x)$ of the density $f(x)$ is given by:

$$\hat{f}_h(x) = \sum_{i=1}^{n} \frac{\theta_i}{h} K\left(\frac{x - X_i}{h}\right), \tag{1}$$

where $K(.)$ is the kernel function and h is the bandwidth that is used for the estimation. Our choice for the bandwidth is based upon the optimality criterion defined by Silverman (1998: 45-48), and estimates the optimal bandwidth as $\hat{h} = 0.9An^{-1/5}$, with A=min(standard deviation, interquartile range/1.34).[2] We use the often-applied Epanechnikov function, $K(z) = \frac{3}{4}\left(1 - z^2\right) \times \mathbf{1}\left(|z| < 1\right)$, as our baseline. Both the choice of the kernel function as well as the bandwidth may have implications for the results that are obtained; in a robustness analysis we will use other bandwidths and kernel functions.

2.2 Counterfactuals

The (observed) distribution of exam results x^a in programs of type a, $f(x^a|a)$, can be written as the integral over all characteristics z of the multiplication of a 'school production function' m that

[1] Details about the data are provided in Section 4. We observe almost all the exam participants and therefore we do not construct sample weights; however, given that the method to construct counterfactuals is based upon reweighting the distributions, we maintain the weights in the equation.

[2] This choice is not necessarily optimal in specific situations, but generally works well.

describes how the characteristics z in program type a are transformed into exam results x^a, with the density h of characteristics in program type a:

$$f(x^a \mid a) = \int_z m(x^a \mid z, a) h(z \mid a) dz \,, \tag{2}$$

for $a \in$ {*accr* (accredited programs), *nonaccr* (non-accredited programs)}.

For both program types we observe the distribution of exam results, but in order to explain the differences between the two distributions, we have to construct counterfactuals that mimic what the distribution would have looked like if a program type would have been populated by students who in reality study at the opposite type. We construct counterfactuals that answer the question "what would the distribution of exam results of students in non-accredited programs have looked like if they would have had the characteristics that are found at accredited programs while being subjected to the production function of non-accredited programs".[3] If we replace the distribution of all characteristics of students in non-accredited programs with the characteristics of those in accredited, $h(z|accr)$, while maintaining the production structure of the non-accredited programs, $m(x|z,nonaccr)$, we obtain the counterfactual distribution $f(x^{nonaccr}|accr)$ of the exam results that would have prevailed if the students from accredited programs would have been at non-accredited programs:

$$f(x^{nonaccr} \mid accr) = \int_z m(x^{nonaccr} \mid z, nonaccr) h(z \mid accr) dz \,. \tag{3}$$

This counterfactual distribution $f(x^{nonaccr}|accr)$ is not observable, because students attend only one program type and are not observed in the other. However, it is possible to write the density in equation (3) as a weighted form of the observable density $f(x^{nonaccr}|nonaccr)$:

$$f(x^{nonaccr} \mid accr) = \int_z m(x^{nonaccr} \mid z, nonaccr) h(z \mid nonaccr) \Psi(z) dz \tag{4}$$

with $\Psi(z) = \dfrac{h(z \mid accr)}{h(z \mid nonaccr)}$, which, by application of Bayes' rule, can be written in terms of observable probabilities, $\Psi(z) = \dfrac{h(z \mid accr)}{h(z \mid nonaccr)} = \dfrac{1 - P(nonaccr \mid z)}{P(nonaccr \mid z)} \dfrac{P(nonaccr)}{1 - P(nonaccr)}$. An estimate of $\Psi(z)$ is easily obtained, because the probability $P(nonaccr)$ can be estimated directly from the

[3] As with the Oaxaca-Blinder decomposition, also DFL does not account for general equilibrium effects, i.e., we ignore that with another selection of students the knowledge acquiring process in the programs might have been different too.

data by the share of students attending non-accredited schools, while estimations of the probabilities conditional upon characteristics *z* ('propensity scores') can be obtained through a logit or probit model explaining program type by the set of characteristics *z*, and calculate the predicted probability of attending a non-accredited program for each individual student given his or her characteristics. Next, the estimate of $\Psi(z)$ can be used as a reweighting factor in the kernel density estimation for the counterfactual distribution,

$$\hat{f}_h(x^{nonaccr} \mid accr) = \sum_{i \in S_{nonaccr}} \frac{\theta_i}{h} \hat{\Psi}(z_i) K\left(\frac{x^{nonaccr} - X_i}{h}\right) \tag{5}$$

The difference between the distributions $f(x^{nonaccr}|accr)$ and $f(x^{nonaccr}|nonaccr)$ arises from differences in the characteristics between the two program types. While the former is estimated by equation (5), an estimation for the latter density can be obtained by applying equation (1) to the sample of students in non-accredited schools.

2.3 Decomposition

A decomposition of the changes in the distribution of exam results between the (observed) results of students in non-accredited programs and the counterfactual distribution of how students with characteristics found in accredited programs would have done if they had attended a non-accredited program is obtained if we do not change all the characteristics at once, but successively construct counterfactuals through a stepwise inclusion of changed characteristics, as outlined by Altonji et al. (2012).

What we intend to decompose is the difference between the observed distributions $f(x^{nonaccr}|nonaccr)$ and $f(x^{accr}|accr)$. First, using the counterfactual based upon all characteristics that we constructed before in equation (4), $f(x^{nonaccr}|accr)$, we can split the difference Δ between the true distributions into an explained and unexplained part:

$$\begin{aligned} \Delta &= f(x^{nonaccr} \mid nonaccr) - f(x^{accr} \mid accr) \\ &= \left\{ f(x^{nonaccr} \mid nonaccr) - f(x^{nonaccr} \mid accr) \right\} + \left\{ f(x^{nonaccr} \mid accr) - f(x^{accr} \mid accr) \right\} \end{aligned} \tag{6}$$

where the first term captures the contribution of the differences in characteristics between the students in non-accredited and accredited programs in the explanation of the observed differences between the two program types, while the second part captures the residual

difference that cannot be assigned to changes in the observed characteristics but instead reflects differences in the production functions.

A sequential decomposition of the difference Δ can be created by successively expanding the set of characteristics of students in accredited programs constructing partial counterfactuals pretending that they attend non-accredited programs. Supposing a partition $z=(z_1, z_2)$, we can write Δ as (cf. DFL:1020):

$$\begin{aligned}\Delta = &\left\{ f(x^{nonaccr} \mid nonaccr) - f(x^{nonaccr} \mid z_1 = accr, z_2 = nonaccr) \right\} + \\ &+ \left\{ f(x^{nonaccr} \mid z_1 = accr, z_2 = nonaccr) - f(x^{nonaccr} \mid accr) \right\} + \\ &+ \left\{ f(x^{nonaccr} \mid accr) - f(x^{accr} \mid accr) \right\},\end{aligned}$$

where the first term captures the effect of the differences of z_1 ("what if non-accredited programs would have students with the characteristics z_1 as found in accredited programs"), the second term captures the effect of differences in z_2 after z_1 has been taken into account already, while the final term captures the residual difference.

In terms of the density functions, by successive application of Bayes' rule, we can write this as (cf. Altonji et al. 2012:791):[4]

$$\begin{aligned}\Delta = &\int m(x^{nonaccr} \mid z_1, z_2, nonaccr)\left[h(z_1, z_2 \mid nonaccr) - h(z_2 \mid z_1, nonaccr)h(z_1 \mid accr)\right]dz \\ &+ \int m(x^{nonaccr} \mid z_1, z_2, nonaccr)\left[h(z_2 \mid z_1, nonaccr)h(z_1 \mid accr) - h(z_1, z_2 \mid accr)\right]dz \\ &+ \int m(x^{nonaccr} \mid z_1, z_2, nonaccr)h(z_1, z_2 \mid accr)dz - \int m(x^{accr} \mid z_1, z_2, accr)h(z_1, z_2 \mid accr)dz\end{aligned} \qquad (7)$$

Similar to the construction in equation (4), again by virtue of Bayes' rule, the counterfactual based upon the characteristics z_1 from accredited program that enters the first two integrals is equal to

$$\begin{aligned}f(x^{nonaccr} \mid z_1 = accr, z_2 = nonaccr) &= \int m(x^{nonaccr} \mid z_1, z_2, nonaccr)h(z_2 \mid z_1, nonaccr)h(z_1 \mid accr)dz \\ &= \int m(x^{nonaccr} \mid z_1, z_2, nonaccr)h(z_2 \mid z_1, nonaccr)h(z_1 \mid nonaccr)\Psi(z_1)dz\end{aligned}$$

with $\Psi(z_1) = \dfrac{h(z_1 \mid accr)}{h(z_1 \mid nonaccr)} = \dfrac{1 - P(nonaccr \mid z_1)}{P(nonaccr \mid z_1)} \dfrac{P(nonaccr)}{1 - P(nonaccr)}$.

[4] Altonji et al. (2012) do not observe the true distribution in their final year, or $f(x^{accr}|accr)$ in our terminology. As DFL, we observe the true distribution under the counterfactual situation. We follow the notation as in DFL, it is not a conditional distribution, it is the true distribution under the counterfactual situation.

The second term in the second integral and the first term in the last integral of equation (7) is the counterfactual defined in equation (4), that is, the counterfactual constructed with the full set of characteristics $z=(z_1, z_2)$, hence, with $\Psi(z)=\Psi(z_1, z_2)$.

The same strategy can be used for decomposition into any partition of the set of characteristics into subsets, $z=(z_1, z_2, \ldots)$ without additional complications, creating a sequential decomposition of the total difference between counterfactual and true distribution into the contributions of each (set of) characteristic(s). Note, however, that the order in which the characteristics are analyzed affects the outcomes. The decomposition in equation (7) remains equally valid if we write $h(z_1 \mid z_2, nonaccr)h(z_2 \mid accr)$, that is, if we first change the characteristics in z_2 to their counterfactual values while maintaining the true values of z_1, giving rise to a reweighting factor $\Psi(z_2)$ instead of $\Psi(z_1)$. Although equally valid, it is not unlikely that the contribution of a set of characteristics differs depending on the order in which the characteristics are entered. Some authors consider there's a natural order of variables (Altonji et al., 2012). The validity of the results can be verified by performing the same analysis but entering the factors in reverse order; we will do that as a robustness analysis.

3. Data

3.1 Data set

The academic performance measure of Colombian undergraduate economics students comes from the standardized, national, Test of Higher Education Quality (ECAES, since 2009 known as SABER PRO), which aims to evaluate some basic competences of final-year undergraduate students.[5] Until the first half of 2011, four specific components were evaluated in the case of economics students: macroeconomics, microeconomics, statistics and econometrics, and economic history and thought.[6] In this paper we use data on undergraduate economics students who presented the 2007 ECAES. The main sources of information of these students are the exam registers and a survey applied by the *Universidad Militar Nueva Granada* to higher education

[5] From 2004 until the first half of 2011, the evaluated competences in Economics ECAES were interpretive, argumentative and purposeful. Since the second half of 2011, the generic competences that have been evaluated were critical thinking, problem solving, interpersonal understanding, and writing.

[6] Since the second half of 2011, related undergraduate programs are grouped. The program of each institution decides which specific competence modules their students present.

institutions that offered an undergraduate economics program and their students coursing last semesters in 2007.

The 2007 ECAES was presented by 2,219 undergraduate economics students, of which only one was not captured by the survey.[7] The survey contains information about secondary education, career development, academic results, employment status while studying, and motivational and other aspects. The survey collects information of 60 institutions that had an active undergraduate economics program at the beginning of 2007; 32 institutions provided the information directly, while the information of the remaining institutions was obtained from secondary sources. There is data such as the institution's location, public/private operation, accreditation status of program and institution. Also, there is program information about curriculum.

3.2 Variables

We analyze the role of accreditation of educational quality in Colombia on academic achievement. The latter is measured by the score reached in the standardized national exam (ECAES) that undergraduate economics students present in the last semesters of their undergrad courses. The accreditation status of the economics program, representing the governmental recognition of the quality of education, is the variable that defines the groups that we will compare. In section 4.2.1 we discuss these two main variables, while in section 4.2.2 we discuss the other variables, grouped by individual, family, program and institutional characteristics, that enter the analysis in order to explain the difference between test scores obtained in non-accredited and accredited economics programs.

3.2.1 Quality indicator, quality difference

Table 1 summarizes the distribution of ECAES exam scores of the 2,211 students that compose the sample.[8] In the bottom line of Table 1 we read that only 34.46% of the economics students in 2007 attended a program that counted with accreditation. The distribution is shown for the full sample (col. 1) and separately for non-accredited (col. 2) and accredited programs (col. 3). We

[7] Presenting ECAES is mandatory for all students in the final year of undergraduate academic programs.

[8] We exclude 8 students who attended two programs that were discontinued shortly after 2007 and that had already halted the acceptance of new students. The mean and variance were normalized at 100 before eliminating these 8 observations.

see that the median student has a score just below the mean. The first quartile is further below the mean (92.8) than the third quartile is above the mean (105.37), but the opposite applies for their distance from the median student. In general, the lower half of the distribution is more compressed than the upper half. The other two columns show that the average score in accredited programs is higher than in the non-accredited programs, but that also the variance is higher. Especially in the non-accredited programs the lower half of the distribution appears more compressed than the upper half, while in accredited programs there are longer and fatter high-score tails.

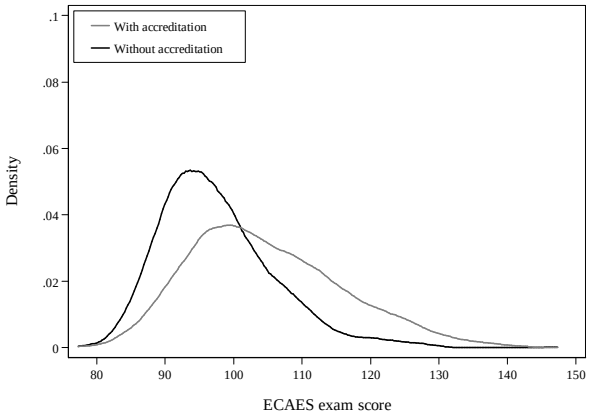
Table 1. Descriptive statistics of ECAES 2007 test scores

Statistics	(1) Full sample	(2) Non-accredited progams	(3) Accredited programs
Mean	100.034	97.530	104.796
Variance	100.125	70.134	122.676
Skewness	0.907	0.956	0.546
Kurtosis	3.876	4.597	2.932
Percentiles			
5%	87.04	86.37	89.02
10%	89.02	88.37	91.56
25%	92.80	91.56	96.37
50% (median)	98.11	96.37	103.17
75%	105.37	102.05	111.98
90%	113.65	108.66	120.54
95%	119.95	113.08	124.83
No. of observations	2,211	1,449	762
% of observations	100	65.54	34.46

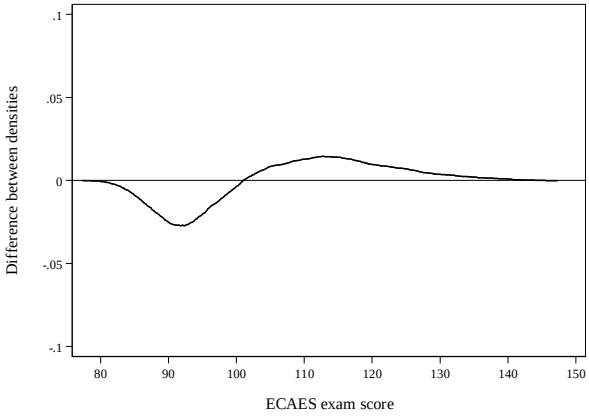
The kernel density estimates of the distributions are plotted in Figure 1 (Panel *a*). The estimates confirm that the density function of non-accredited programs is to the left of the density function of the accredited programs. Panel *b* of Figure 1 shows the difference between the two estimated kernel density functions, which highlights the disparity related to the accreditation in the density of exam scores. As is evident, differences exist throughout the ECAES exam score distributions, so it is important to determine the factors affecting the quality of education in different parts of the distribution function of the ECAES test scores.

Figure 1. Kernel density estimates of ECAES 2007 test scores

a. Kernel density estimates by accreditation status



b. Difference between the accredited and non-accredited density functions



3.2.2 Other explanatory variables

Following the literature, and taking into account availability, we construct four sets of characteristics. In the group of individual characteristics are sex, age, age squared, marital status, semester at survey, and their score at the end of secondary education in the standardized national exam (SABER-11). In the group of family or household characteristics we include the level of education and the occupation of both parents, and the households' socio-economic status. In the group of program characteristics are the numbers of mandatory courses in microeconomics, macroeconomics, statistics and econometrics, and economic history and thought as well as the total number of courses to be taken. Furthermore, the average tuition fee (linear and squared) for the program and the number of economics students relative to the total number of students at the institute are included as program characteristics. The group of institutional characteristics

contains indicators regarding if it was a public or private institution, if the institution was accredited or not, in which part of Colombia it was located, and the total number of students enrolled in the university.

Table 2 presents the descriptive statistics for these variables. There is a larger participation of women in the 2007 ECAES test (57.5%), being slightly higher in non-accredited programs. The average test taker is 24.1 years old, while the average age is 24.5 years among those in the non-accredited programs and only 23.3 in the accredited programs. Furthermore, the higher average age among test takers in non-accredited programs is accompanied by a higher standard deviation. Hence, non-accredited programs appear more attractive among more mature students. Evaluated students are generally single (91.7%), although 10.2% students in non-accredited programs live together with a partner (either married or unmarried) versus 4.7% in accredited programs. The average score at the SABER 11 secondary education test is somewhat higher for students in accredited programs (56.4 points) compared with those in non-accredited programs (50.8), but in both groups the variance is high. For about 3.9% of students we do not know their SABER 11 score, a condition that is more common among students in non-accredited programs.

Parental education of test takers is concentrated on graduate studies (45.9% for fathers, 39.9% for mothers, considering specialization/master's/Ph.D., bachelor's and higher vocational), secondary education (31% for fathers, 40.3% for mothers, considering also secondary vocational), while a relatively small group (in comparison with the population in general) has parents that took only primary school (19.3% for fathers, 18% for mothers) or no formal schooling at all (3.8% for fathers, 1.9% for mothers). When the sample is divided by accreditation status, parental education concentrates principally in graduate studies (59.6% for fathers, 55% for mothers) for accredited programs, and on secondary education (34.3% for fathers, 44.1% for mothers) for non-accredited programs. The test takers in accredited programs are strongly concentrated in the higher socio-economic strata while in non-accredited programs the lower socio-economic strata are more common, although on the whole the higher strata are solidly overrepresented in comparison with the general population.[9]

[9] Colombia has an official socio-economic stratification system that is used e.g. for targeting subsidies and contributions in the utilities sector. In 2005, 22.3% of the population was classified in stratum 1, 41.2% in stratum 2, 27.1% in stratum 3, 6.4% in stratum 4, 1.9% in stratum 5, 1.2% in stratum 6 (CONPES Document 3386).

Taken together, the descriptive statistics of the individual and family characteristics suggest that students in non-accredited programs more often come from a less advantaged situation and may take the education to advance in life. Therefore it is of ultimate importance that they receive high-quality education that allows them to bridge the gap that might be inherited from the background of their family or generated by early-life decisions.

The structure of the mandatory part of the curriculum of the undergraduate economics programs is relatively similar between accredited and non-accredited programs. There is a stronger emphasis on macroeconomic courses (approximately 10.5 for accredited and 11.8 for non-accredited), in contrast with approximately three to four courses for each of the other areas distinguished in the analysis. The total number of courses in the curriculum is much higher, about 53, but also very similar in accredited and non-accredited programs. Apart from the mandatory courses in the mentioned areas, the total number of courses includes room for optional courses and for mandatory courses in accounting, administration, languages, etc. On average, tuition is more expensive in accredited than in non-accredited programs (COP 3,352,826 versus COP 1,528,899).[10] In general, the economics undergraduate programs form only a small part in the institutions that organize them; the average student is in a program that enrolls 4.5% of the institute's total student population. For students in accredited programs the share of economics students is a little higher (economics students represent 5.7% of all students of the institution from accredited programs versus 3.8% from non-accredited programs).

Students in accredited programs are more concentrated in private institutions (87.8%) than students in programs without accreditation (62.5% private). Overall, more than 71% of the students who presented the ECAES 2007 were in private institutions. Not all the accredited economics programs are in an accredited university, however it is more common to see that both are accredited than to find a non-accredited program in an accredited university (38.6% versus 13.2%). Overall, only 21.9% of the test takers did so at a university with accreditation. Accredited programs are concentrated in Bogotá (the capital of Colombia; 72.8%) while non-accredited programs are more frequently found outside the major departments (Bogotá, Antioquia, and Valle; 44.6%). The total number of students at the institutions (in economics and other programs) is higher in accredited programs.

[10] One thousand Colombian pesos (COP 1,000) was equivalent to about USD 0.50 in 2007.

Table 2. Descriptive statistics of the background characteristics

Variables	(1) Full sample	(2) Non-accredited progams	(3) Accredited programs
Individual characteristics			
Age	24.114	24.529	23.325
	(3.705)	(4.002)	(2.906)
Sex			
Female	0.575	0.588	0.551
Male	0.425	0.412	0.449
Marital status			
Single	0.917	0.898	0.953
Couple	0.083	0.102	0.047
Semester			
6	0.035	0.030	0.046
7	0.030	0.032	0.026
8	0.112	0.083	0.168
9	0.436	0.418	0.471
10	0.350	0.395	0.264
> 10	0.036	0.042	0.025
SABER 11 score (secondary education national exam)	52.740	50.828	56.376
	(12.817)	(12.784)	(12.079)
Family characteristics			
Father's education level			
Primary	0.193	0.230	0.123
Secondary	0.267	0.297	0.210
Secondary vocational	0.043	0.046	0.035
Higher vocational	0.115	0.114	0.117
Bachelor’s	0.229	0.197	0.290
Specialization/Master’s/Ph.D.	0.115	0.077	0.189
No formal schooling/Pre-primary/NA	0.038	0.040	0.035
Mother's education level			
Primary	0.180	0.219	0.105
Secondary	0.338	0.378	0.261
Secondary vocational	0.065	0.063	0.068
Higher vocational	0.129	0.110	0.165
Bachelor’s	0.173	0.138	0.239
Specialization/Master’s/Ph.D.	0.097	0.072	0.146
No formal schooling/Pre-primary/NA	0.019	0.020	0.016
Father's occupation			
Entrepreneur	0.072	0.050	0.114
Administrator/Manager	0.052	0.040	0.075
Professional self-employed	0.090	0.074	0.119
Professional employee	0.105	0.092	0.130
Self-employed	0.288	0.310	0.245
Employee	0.104	0.114	0.085
Rentier/Retired	0.149	0.157	0.133
Homemaker/Laborer	0.046	0.059	0.021
Student/Do not earn income/NA	0.095	0.104	0.077
Mother's occupation			
Entrepreneur	0.035	0.026	0.054
Administrator/Manager	0.032	0.020	0.054
Professional self-employed	0.047	0.034	0.071
Professional employee	0.118	0.099	0.155
Self-employed	0.147	0.155	0.131

Variables	(1) Full sample	(2) Non-accredited progams	(3) Accredited programs
Employee	0.104	0.108	0.097
Rentier/Retired	0.096	0.093	0.102
Homemaker/Laborer	0.368	0.405	0.298
Student/Do not earn income/NA	0.053	0.061	0.038
Household's stratum			
1 (poorest)	0.038	0.048	0.020
2	0.163	0.196	0.100
3	0.412	0.451	0.340
4	0.212	0.190	0.252
5	0.100	0.071	0.155
6 (richest)	0.075	0.043	0.134
Program characteristics			
Tuition fee (thousand COP)	2,157.498	1,528.899	3,352.826
	(1,950.014)	(1,096.036)	(2,563.994)
No. of core courses in microeconomics	3.284	3.064	3.703
	(0.951)	(0.924)	(0.857)
No. of core courses in macroeconomics	11.361	11.820	10.490
	(4.710)	(3.989)	(5.743)
No. of core courses in statistics and econometrics	3.897	3.963	3.773
	(0.699)	(0.705)	(0.670)
No. of core courses in economic history and thought	2.932	2.749	3.278
	(1.559)	(1.491)	(1.626)
Total no. of core courses	52.716	52.173	53.748
	(11.076)	(9.903)	(12.963)
Share of economics students in the institute's total no. of students	0.045	0.038	0.057
	(0.040)	(0.027)	(0.056)
Institutional characteristics			
Public/Private institution			
Public	0.288	0.375	0.122
Private	0.712	0.625	0.878
Accreditation status of the institution			
Non-accredited	0.781	0.868	0.614
Accredited	0.219	0.132	0.386
Department where the university is located			
Bogotá	0.461	0.320	0.728
Antioquia	0.099	0.117	0.064
Valle	0.119	0.117	0.125
Other departments	0.321	0.446	0.083
Total no. of students	10,232.264	9,103.280	12,379.110
	(6,809.090)	(6,633.548)	(6,623.648)
No. of observations	2,211	1,449	762

Standard deviations in parentheses

4. Results

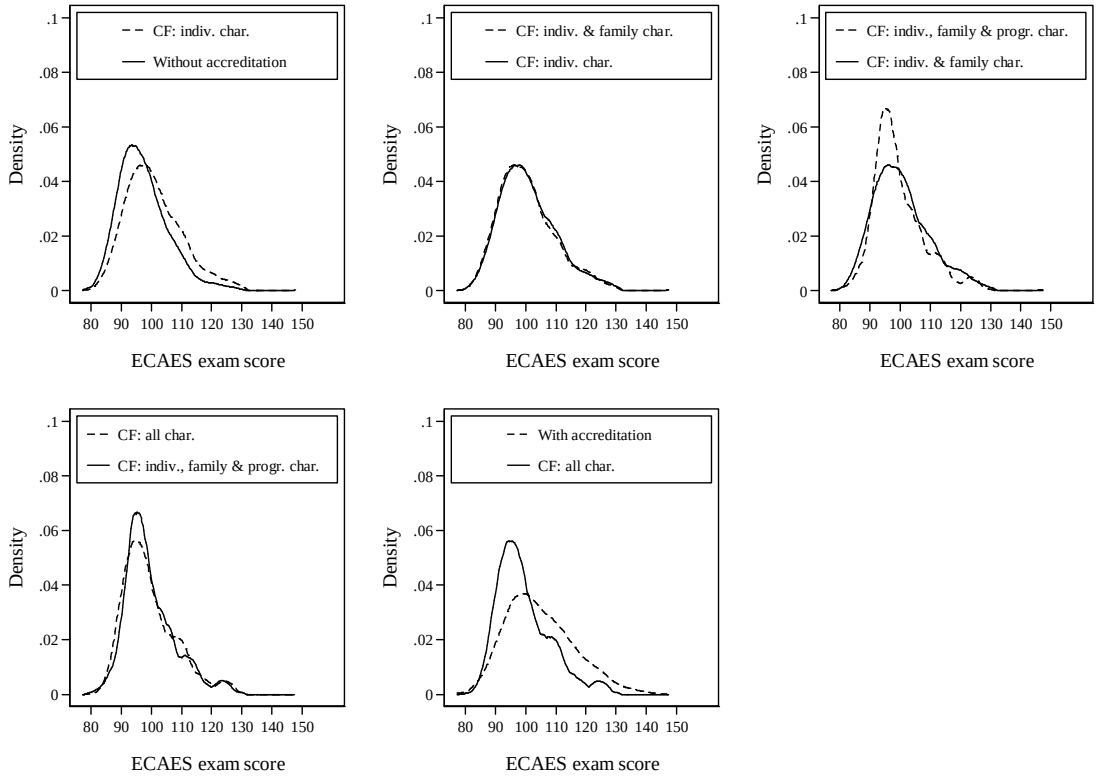
As explained in Section 3, we implemented a series of steps to estimate the counterfactuals used to explain whether all students of economics departments in Colombia had the same opportunities to achieve satisfactory academic performance. For each counterfactual, in the first

stage we estimated a probit model to calculate the probability that a student belonged to a non-accredited economics program given the characteristics that enter the construction of the counterfactual at hand, a successive expansion of the set of controls with individual, family, program and institutional characteristics (the probit model estimates are included in Appendix 1). The next step of the DFL methodology is to assign a weight $\Psi(\cdot)$ to each student, based on the estimated probability of belonging to a program without accreditation given their observable characteristics. Then, we use the kernel estimator (eq. (5)) for the sample of students in non-accredited programs with the previously calculated weights.

The solid line in the upper-left panel of Figure 2 is the kernel density function of the scores of students in non-accredited programs, while the dotted line illustrates the estimated counterfactual density function of the scores in non-accredited programs if the individual characteristics (z_1) were from the students of programs with accreditation (that is, with a reweighting function based upon the probit model in the first column of

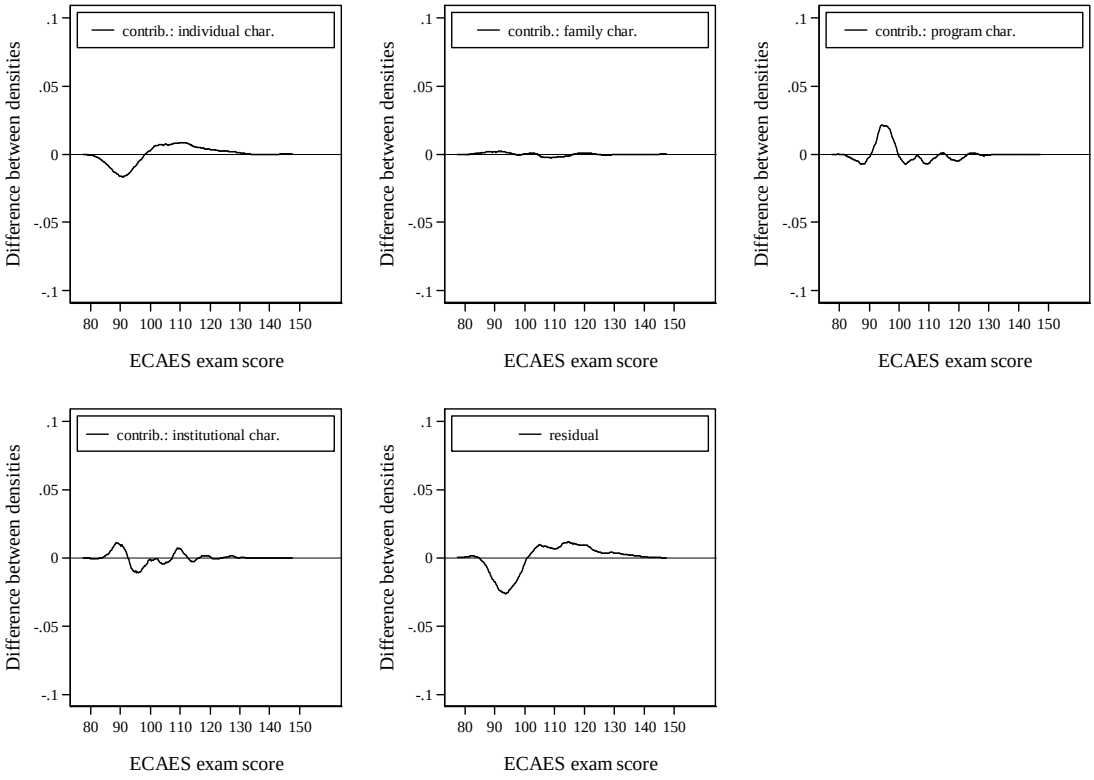
Table A1). The counterfactual density function lies to the right of the density function of the scores of programs without accreditation. This suggests that students in non-accredited programs increase their performance if they had the individual characteristics of students programs with accreditation. The less favorable combination of individual characteristics as addressed in Section 4.2.2 has a clear contribution to the explanation of the lower scores observed in the nonaccredited programs in comparison with the accredited programs. The upper-left panel of Figure 3 shows the difference between both density funtions, which reflects the contribution of the students' individual characteristics on the score distribution. It clearly shows that the higher range of scores gain weight in favor of the lower end of the distribution when students in non-accredited programs would have had the characteristics of those who study in accredited programs.

Figure 2. Estimated density for non-accredited programs and different counterfactuals



To analyze the additional effect of family variables, we compare the counterfactual density function of the scores obtained by students in non-accredited programs based upon the individual characteristics (z_1) of accredited programs' students, represented by the solid line in the upper-central panel of Figure 2, with the counterfactual based upon both individual and family characteristics (z_1, z_2) of accredited programs' students, represented by the dotted line in the same panel. The two estimated counterfactual density functions are very similar, which suggests that students from non-accredited programs would have similar performance if they had the family characteristics of students from programs with accreditation, and that family characteristics has no additional effect on the distribution of scores once we have controlled for differences in the individual characteristics (see also the upper-central panel of Figure 3).

Figure 3. Contributions of the different groups of explanatory variables



The upper-right panel of Figure 2 deals with the effect of characteristics of the economics program, comparing the counterfactual density function of the scores obtained by students in non-accredited programs considering individual and family characteristics (z_1, z_2) from accredited students, represented by the solid line, with the counterfactual based upon individual, family and program characteristics (z_1, z_2, z_3), which is represented with the dotted line. The estimated counterfactual density functions are different mainly around the mean, reducing the number of students with higher scores and just below the mean while showing a tendency towards concentration at the mean, which is even more evident from the upper-right panel of Figure 3. This suggests that students from non-accredited programs who scored below-average would have had better performance if they had studied in programs with the characteristics of accredited programs (after the differences in individual and family characteristics are taken into account). However students from non-accredited programs above the average reduced their scores when accredited programs characteristics are imposed. The program characteristics do not make a difference for those who scored very good. In general, the characteristics from the

accredited programs seems to be favorable for the mean scores. Hence, the effect of the program characteristics suggests that the accredited programs have features that help the less-advantaged students more than the students above the average.

To indicate the effect of the institutional characteristics, we compare the density function of the scores obtained by students in non-accredited programs taking into account individual, family and program characteristics (z_1, z_2, z_3), represented by the solid line in the bottom-left panel of Figure 2, with the counterfactual that accounts for all characterics, that is, for individual, family, program and institutional characteristics (z_1, z_2, z_3, z_4), based upon the probit model in the final column of

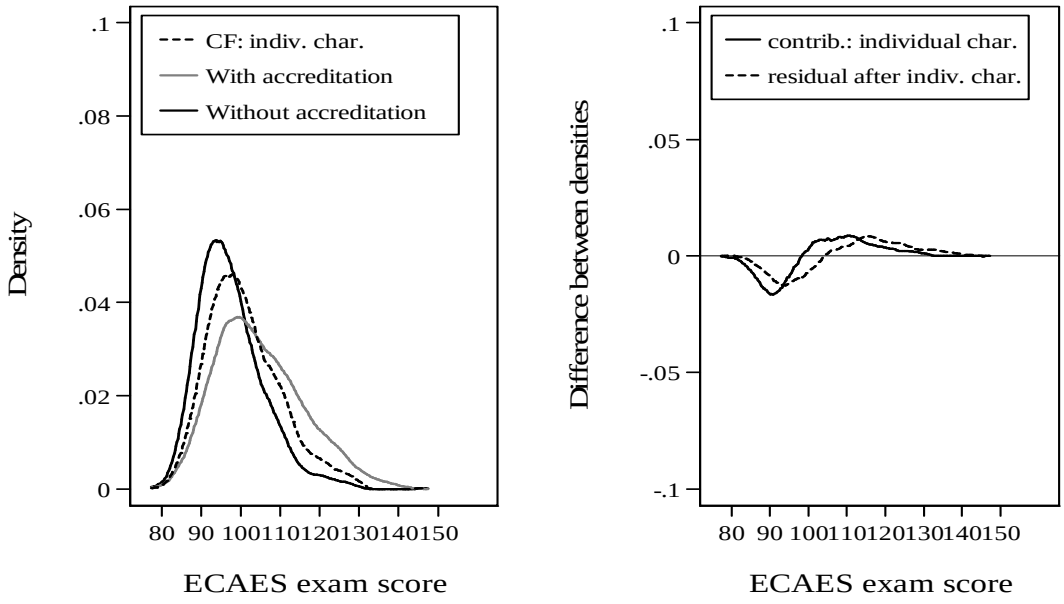
Table A1 and represented by the dotted line in the same panel. As illustrated also by the bottom-left panel of Figure 3, the estimated counterfactual density functions are different mainly for students from non-accredited programs with a performance close to the mean. Imposing the characteristics of accredited institutions leads to decreased density of the middle scores, an increase the dispersion around the mean. This effect appears to go against the effect of the program characteristics. The institutional characteristics from accredited programs do not seem more beneficial than the institutional characteristics from non-accredited programs; there is some increase in the density of above-average scores, but the density below the mean increases more.

Finally, we compare the counterfactual based upon the full set of controls (z_1, z_2, z_3, z_4) represented by the solid line, with the true density in accredited universities represented by the dotted line in the bottom-central panel of Figure 2. It shows that the estimated counterfactual density function that describes how students in non-accredited programs would have fared if they had all the observable (individual, family, program, and university) characteristics of students from accredited programs, is quite different from the density function of the scores of accredited programs. The difference in the bottom-central panel of Figure 3 is the residual effect that is not explained by the observed characteristics. After the middle part of the distribution the estimated counterfactual density function lies below the kernel density function of the true scores of accredited programs. The (rather large) difference between the two densities suggests that there are other factors that differ between accredited and non-accredited program, for example their production functions, and/or their students that explain the difference in scores. The residual part not explained by the observed factors captures a shift from the lower part of the

distribution toward the higher scores, suggesting that there are other (unexplained) differences in the production process that are more efficient in the accredited programs.

In short, the gap between the performance of students from accredited and non-accredited programs was not only present at the mean (the 100 score), the gap was present along the entire distribution. Interesting to consider is that the individual characteristics explained the gap along almost the entire distribution of academic performance, as is shown in Figure 4. The left panel shows the true densities and the counterfactual using only individual characteristics, while the right-hand panel even more clearly shows that the residual after accounting for the individual characteristics is rather small and closes a large part of the gap between the densities in accredited and non-accredited programs. The family features were the least likely explanation for the differences. In general, the relevance of the program features – after accounting for individual and family characteristics – is to improve the middle scores. Program and institutional characteristics have partly opposite effects. These two groups of features appear to have a somewhat erratic behavior that is not easy to interpret and moreover reinforces larger gaps between the distributions, gaps that had almost completely disappeared by controlling for individual (and family) characteristics.

Figure 4. True distributions vs. counterfactual based upon individual characteristics



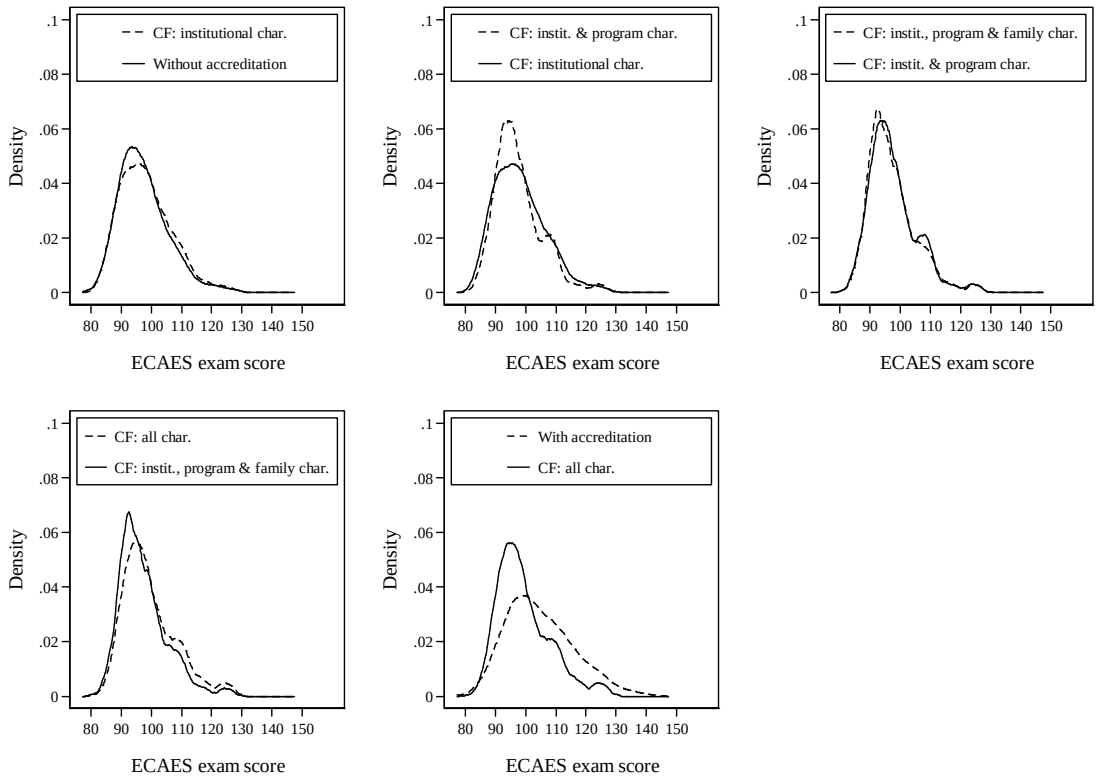
4.1 Robustness checks

We performed several analyses to confirm the robustness of the conclusions for alternative choices regarding the specification of the model. In section 5.1.1. we address the issue of path dependence inherent to the methodology by entering the groups of variables in the opposite order. Section 5.1.2 considers alternative choices for the kernel function, while section 5.1.3 uses the students in accredited programs as the baseline and analyzes what would be the score distribution if they had had the characteristics of non-accredited program students.

4.1.1 Opposite order

In Figure 5 we show the same analysis as in Figure 2 but entering the groups of characteristics in the opposite order, starting with institutional characteristics (upper-left), followed by program (upper-central), family (upper-right) and individual characteristics (bottom-left), while the residual in the bottom-central panel remains unchanged after controlling for all characteristics.

Figure 5. Estimated counterfactuals when characteristics are entered in the opposite order



It is clear that the order does not seem to matter, the role of each group of characteristics is the same as in Figure 2. The conclusion remains unchanged: it is mainly the individual characteristics that drives the lower performance of students at non-accredited economics programs in the ECAES 2007, in comparison with students taking an accredited program. Organizational features of the programs and institutions are hardly able to compensate the disadvantages that the students bring with them at the start of their undergraduate program.

4.1.2 Alternative kernel functions

Figure 6 shows the counterfactuals when a Gaussian kernel function, $K(z)=\frac{1}{\sqrt{2\pi}}\exp\left(-\frac{1}{2}z^2\right)$, is used instead of the Epanechnikov kernel as specified in Section 3.1. Note that DFL used a Gaussian kernel. Each panel of Figure 6 looks very similar to the respective panels of Figure 2, suggesting that the results are not very sensisitive for the choice of the kernel function.

Figure 6. Estimated counterfactuals using a Gaussian kernel density function

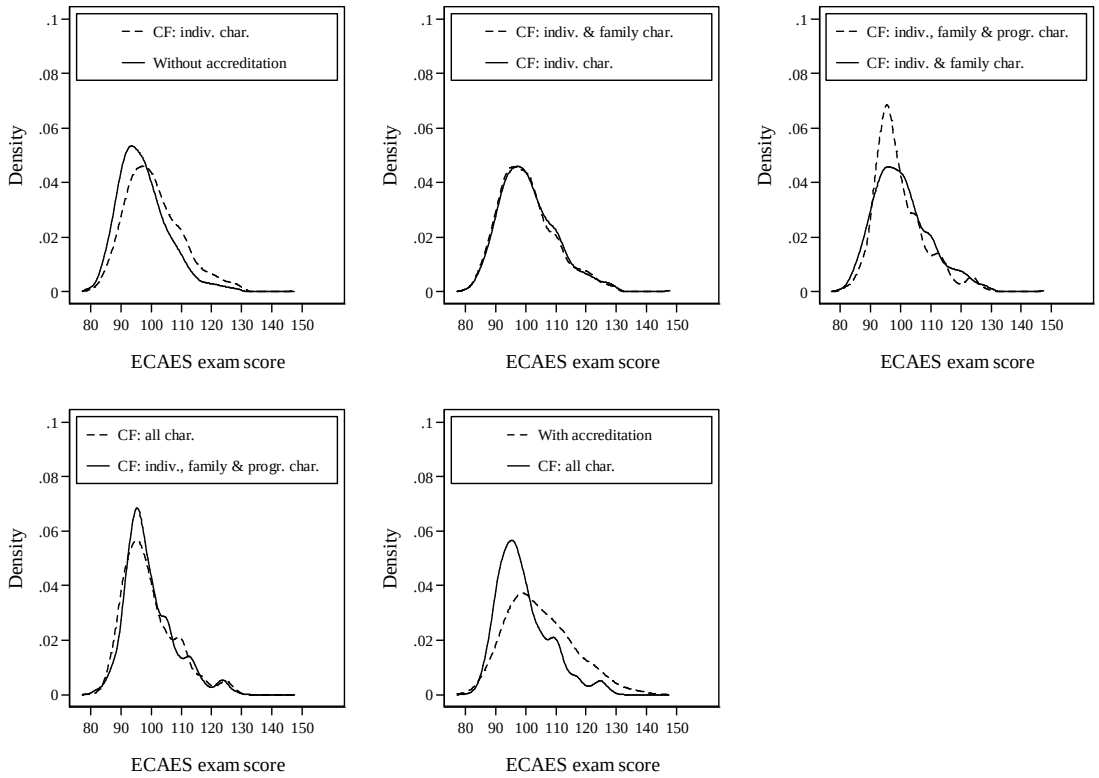
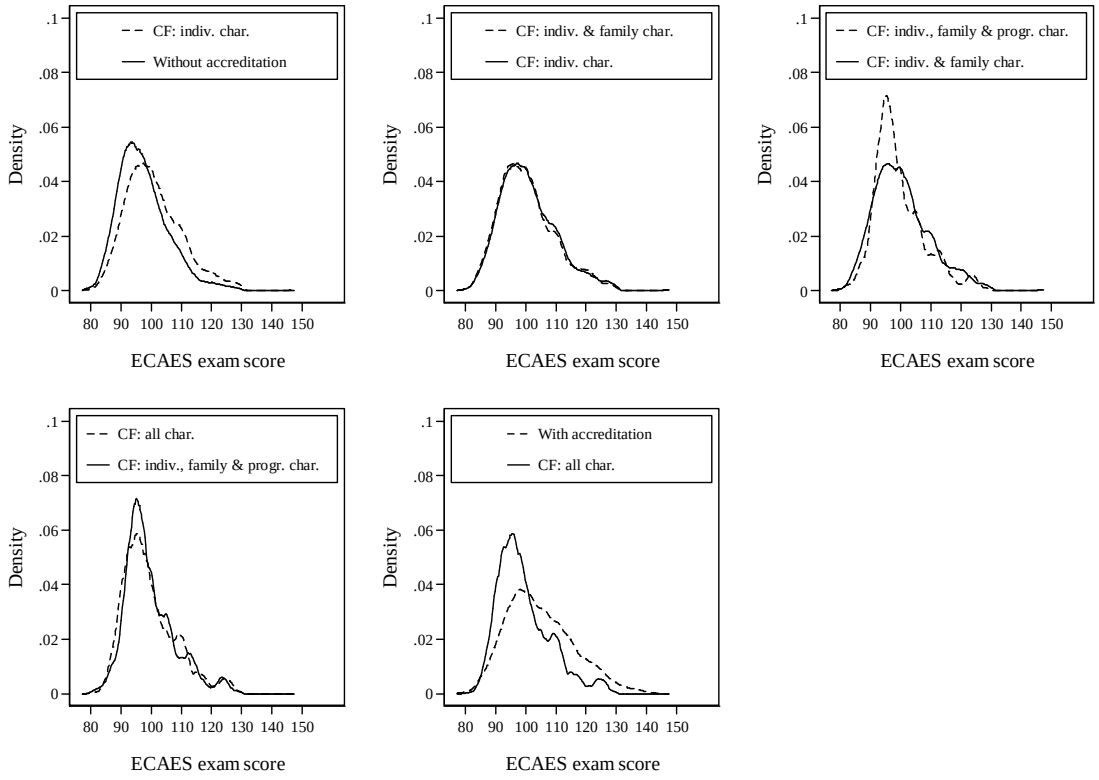


Figure 7. Estimated counterfactuals using bandwidth equal to 75% of the optimal bandwidth



Another choice that must be made is the bandwidth for the kernel density estimator. As said in Section 3.1 we use an optimal choice for the bandwidth based upon Silverman (1998) that generally works well. It is based upon the assumption of an underlying Gaussian distribution, and it has been shown that in case of skewed distributions it is too wide. Therefore we run the analysis also with a smaller bandwidth, in particular, Figure 7 shows the counterfactuals estimated using bandwidth equal to 75% of the optimal bandwidth that has been used for Figure 2. Figure 7 is highly similar to Figure 2, although slightly more peaked especially for the program and institutional characteristics.

Overall, these results suggest that the kernel function and the bandwidth choice are not the main driving forces for our results.

4.1.3 Accredited programs as the baseline group

We could have used the students at accredited programs as our baseline group, and see how they would have fared had they had characteristics that would be more similar to characteristics found with the students in the non-accredited programs. In that case, we would expect a picture that more-or-less mirrors what we have seen until now. However, a purely symmetric effect is not necessary, and not even likely. The (first step) probit models will give exactly the same only with opposite signs, but in the subsequent steps the propensity scores based upon the probit models are used to calculate the reweighting factor for the other part of the sample. Instead of reweighting the non-accredited students, we will now reweight the accredited students (a smaller sample) in order to mimic non-accredited characteristics.

Figure 8 and 9 show the results. With regard to the individual and family characteristics, we –indeed– find a mirror picture. For program characteristics this is not the case, especially the pronounced peak around the 100 score disappears; in the distribution three peaks appear at the below-around-above mean scores, suggesting that a change of accredited program characteristics toward those of the non-accredited ones leads to an erratic behavior of the density function of scores. Adding the institutional characteristics of non-accredited institutions pronounces the erratic peaks in the distribution of scores of students from accredited institutions.

The outcomes suggest, consistent with the main results, that primarily the individual characteristics help to explain the higher scores of students at accredited programs in the ECAES exam, while the family background does not add much. On the other hand, the program and institutional characteristics present an erratic behavior.[11]

[11] Probably because in the small sample of students in accredited programs we get, in the reweighting procedure, that $P[accr\ |z] \approx 0$ and hence $\Psi(z) \rightarrow \infty$, with obvious consequences for the density function.

Figure 8. Estimated counterfactuals using non-accredited programs as the baseline group

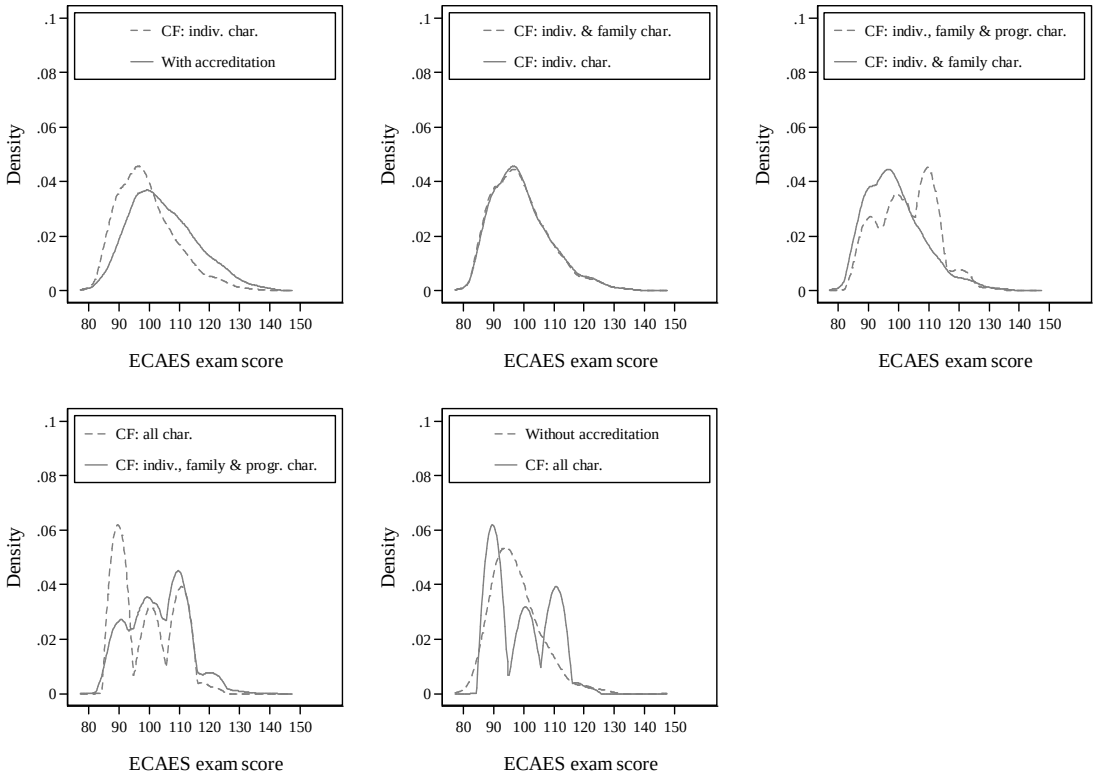
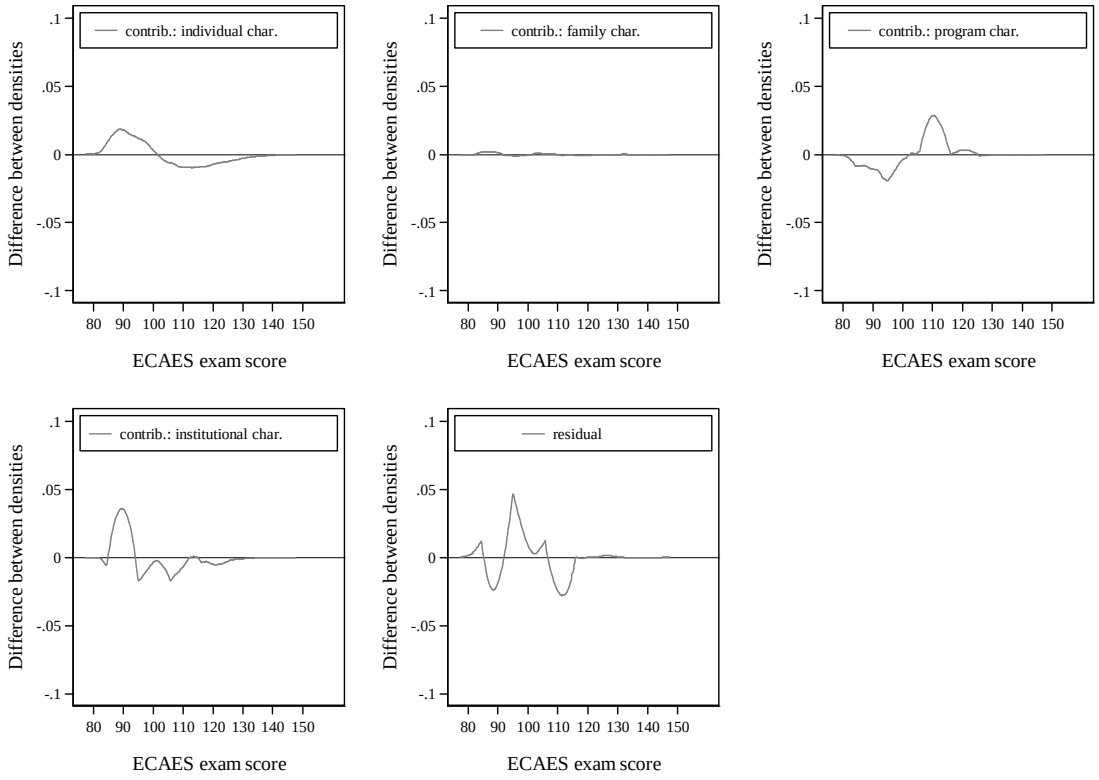


Figure 9. Differences using non-accredited programs as the baseline group



5. Conclusions

The aim of this paper was to study the quality of education in the undergraduate programs at economics faculties in Colombia. Specifically, we analyzed which factors can explain the difference between students from accredited and non-accredited universities in the standardized national exam (ECAES) that students presented in last semesters of their undergraduate courses during 2007. Using the DiNardo, Fortin, and Lemieux (1996) methodology we estimated the distribution of scores that would have been obtained by students in non-accredited economics programs if they would have had the observable characteristics of students from accredited programs. The density functions allowed us to study other points in the distribution besides the mean, what turned out to be important because we established that the gap between the performace of students from accredited and non-accredited programs was not only present at the mean but along the entire distribution. Hence, for a better understanding of the opportunities to achieve a satisfactory academic performance for students of undergraduate economics programs

in Colombia, it is relevant to determine the factors that could affect the quality of education for students at different points of the distribution function.

We found that the importance of each group of features, distinguishing between individual, family, program and institutional characteristics, in the explanation the differences between test scores in accredited and non-accredited programs varies over the distribution. Analyzing how students in non-accredited programs would have fared when the characteristics from accredited programs had applied, we found that the individual characteristics contributed to the explanation of the gap along almost the entire distribution of academic performance, while family features contributed least. The program features lead to a concentration at the mean score of the distribution attracting both students who performed below and above the mean, while the institutional characteristics had influence in the opposite way to the program features, pushing students away from the mean both towards higher and lower scores.

The finding that differences in individual characteristics of students explain an important part of the educational gap in the distribution of scores between accredited and non-accredited programs in economics, strongly suggests that efforts should be made to focus public policies at improving the previous education, which is now reflected by a lower performance in the standarized tests at the end of secondary education (SABER 11). Better secondary education provides more favorable conditions for the students, but policy makers have faced difficulties for the design and implementation of quality policies on secondary education in the short or medium term.

For low-performing students the features of the programs become important in order to increase their scores. It would be appropriate to focus on improving the quality of the educational programs for students with poor academic performance by improving the intensity in the core courses of the education of economists. Furthermore, for the academic performance of those around the mean it is necessary to diminish the disparity between regions, tuition costs and between public and private institutions.

Finally, despite our contribution to the understanding of the disparities in academic performance between accredited and non-accredited programs, our results suggest that different forms of output generation in the undergraduate economics programs remain. In this sense, the programs with accreditation were more efficient in transforming the available inputs.

Although it is difficult to generalize the results to other developing countries, and perhaps even to other fields than economics faculties, our results are consistent with the literature that highlights the importance of parental circumstances and early-childhood characteristics in the outcomes later in life (Currie, 2009). Where quality control by program accreditation frameworks is definitely important, we cannot ignore that many decisions regarding access to and selection of programs are already made or determined by decisions or situation early in the life. Our results show that even in the select group of university students, where the highest social strata are strongly overrepresented – especially in the accredited programs –, characteristics determined early in life are important factors for later success. Beneficial interventions in early stages may have long-lasting effects not only for those who end up in university but also for others who may not have the intellectual capacities to reach the top, but can benefit from good education at lower levels. It is of ultimate importance that public programs permit everyone to develop up to the maximum of their capacities.

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Appendix 1. Probit regressions for the propensity scores

Table A1. Probit models based on different sets of characteristics

	(1) Only Individual Char.		(2) Plus Family Char.		(3) Plus Program Char.		(4) Plus Institutional Char.	
Age	0.059		0.025		-0.020		0.166	
	(0.071)		(0.072)		(0.102)		(0.130)	
Age squared	-0.000		-0.000		0.000		-0.003	
	(0.001)		(0.001)		(0.002)		(0.002)	
Sex (ref. cat.: Female)								
Male	-0.062		-0.018		-0.091		-0.146	
	(0.060)		(0.062)		(0.085)		(0.110)	
Marital status (ref. cat.: Single)								
Couple	0.182		0.168		0.267	*	0.250	
	(0.121)		(0.123)		(0.161)		(0.203)	
Semester (ref. cat.: 6)								
7	0.547	**	0.639	***	0.164		0.359	
	(0.221)		(0.228)		(0.315)		(0.383)	
8	-0.029		0.097		-0.003		-0.175	
	(0.170)		(0.176)		(0.244)		(0.318)	
9	0.284	*	0.324	**	0.168		0.443	
	(0.154)		(0.158)		(0.212)		(0.286)	
10	0.462	***	0.466	***	0.314		0.516	*
	(0.156)		(0.160)		(0.214)		(0.293)	
> 10	0.465	**	0.463	**	0.832	***	1.503	***
	(0.220)		(0.226)		(0.307)		(0.393)	
SABER 11 score (secondary education national exam)	-0.053	***	-0.046	***	-0.043	***	-0.034	***
	(0.004)		(0.004)		(0.007)		(0.009)	
SABER 11 score unknown	-2.764	***	-2.369	***	-2.575	***	-2.033	***
	(0.286)		(0.298)		(0.421)		(0.547)	
Father's education level (ref. cat.: Primary)								
Secondary			0.020		0.156		0.186	
			(0.103)		(0.137)		(0.186)	
Secondary vocational			0.191		-0.000		-0.121	
			(0.177)		(0.243)		(0.324)	
Higher vocational			-0.004		0.053		-0.026	

	(1) Only Individual Char.	(2) Plus Family Char.		(3) Plus Program Char.	(4) Plus Institutional Char.	
		(0.125)		(0.167)	(0.226)	
Bachelor's		-0.124		0.043	-0.104	
		(0.125)		(0.167)	(0.220)	
Specialization/Master's/Ph.D.		-0.240		0.012	0.058	
		(0.152)		(0.215)	(0.280)	
No formal schooling/Preschool/NA		-0.202		0.001	-0.183	
		(0.184)		(0.245)	(0.355)	
Mother's education level (ref. cat.: Primary)						
Secondary		-0.057		0.039	0.111	
		(0.104)		(0.138)	(0.191)	
Secondary vocational		-0.265	*	-0.158	-0.002	
		(0.153)		(0.215)	(0.288)	
Higher vocational		-0.295	**	-0.220	-0.243	
		(0.130)		(0.172)	(0.231)	
Bachelor's		-0.167		0.162	0.461	*
		(0.137)		(0.186)	(0.248)	
Specialization/Master's/Ph.D.		-0.179		0.323	0.502	*
		(0.160)		(0.231)	(0.305)	
No formal schooling/Preschool/NA		-0.252		-0.301	-0.707	
		(0.249)		(0.319)	(0.456)	
Father's occupation (ref. cat.: Entrepreneur)						
Administrator/Manager		0.144		0.227	0.064	
		(0.172)		(0.265)	(0.331)	
Professional self-employed		0.205		0.230	-0.036	
		(0.154)		(0.235)	(0.303)	
Professional employee		0.251	*	0.024	-0.091	
		(0.152)		(0.231)	(0.291)	
Self-employed		0.083		-0.253	-0.235	
		(0.138)		(0.216)	(0.272)	
Employee		0.064		-0.267	-0.163	
		(0.157)		(0.238)	(0.301)	
Rentier/Retired		0.292	**	0.113	0.060	
		(0.145)		(0.224)	(0.279)	
Homemaker/Laborer		0.454	**	0.152	-0.212	
		(0.207)		(0.294)	(0.419)	
Student/Do not earn income/NA		0.207		-0.180	-0.099	

	(1) Only Individual Char.		(2) Plus Family Char.		(3) Plus Program Char.		(4) Plus Institutional Char.	
			(0.162)		(0.242)		(0.305)	
Mother's occupation (ref. cat.: Entrepreneur)								
Administrator/Manager			-0.004		-0.100		0.069	
			(0.227)		(0.335)		(0.427)	
Professional self-employed			0.118		0.153		0.413	
			(0.211)		(0.314)		(0.376)	
Professional employee			0.179		0.087		0.362	
			(0.186)		(0.277)		(0.340)	
Self-employed			0.251		0.432		0.544	*
			(0.186)		(0.269)		(0.322)	
Employee			0.200		0.234		0.505	
			(0.190)		(0.271)		(0.328)	
Rentier/Retired			0.141		0.077		0.556	*
			(0.191)		(0.278)		(0.332)	
Homemaker/Laborer			0.276		0.375		0.759	**
			(0.173)		(0.256)		(0.309)	
Student/Do not earn income/NA			0.392	*	0.794	**	1.193	***
			(0.216)		(0.312)		(0.393)	
Household's stratum (ref. cat.: 1 (poorest))								
2			0.089		-0.073		0.683	*
			(0.187)		(0.237)		(0.381)	
3			-0.082		-0.405	*	0.522	
			(0.180)		(0.237)		(0.369)	
4			-0.172		-0.238		0.463	
			(0.189)		(0.254)		(0.387)	
5			-0.400	**	0.039		0.365	
			(0.202)		(0.277)		(0.405)	
6 (richest)			-0.452	**	0.361		0.423	
			(0.214)		(0.300)		(0.430)	
Tuition fee (thousand COP)					0.002	***	-0.001	**
					(0.000)		(0.000)	
Tuition fee squared					-0.000	***	-0.000	**
					(0.000)		(0.000)	
No. of core courses in microeconomics					-0.598	***	-0.278	***
					(0.056)		(0.089)	
No. of core courses in macroeconomics					0.077	***	-0.061	**

	(1) Only Individual Char.		(2) Plus Family Char.		(3) Plus Program Char.		(4) Plus Institutional Char.	
					(0.014)		(0.026)	
No. of core courses in statistics and econometrics					1.864	***	3.155	***
					(0.115)		(0.203)	
No. of core courses in economic history and thought					-0.268	***	-0.739	***
					(0.038)		(0.072)	
Total no. of core courses					-0.159	***	-0.129	***
					(0.008)		(0.013)	
Share of economics students in the institute's total no. of students					-8.687	***	-9.741	***
					(1.285)		(1.734)	
Public/Private institution (ref. cat.: Public)								
Private							-2.137	***
							(0.458)	
Accreditation status of the institution (ref. cat.: Non-accredited)								
Accredited							0.979	***
							(0.301)	
Department where the university is located (ref. cat.: Bogotá)								
Antioquia							1.593	***
							(0.313)	
Valle							0.835	***
							(0.185)	
Other departments							0.812	***
							(0.222)	
Total no. of students							-0.000	***
							(0.000)	
Constant	1.842	*	1.942	*	5.931	***	4.769	**
	(1.002)		(1.051)		(1.490)		(1.985)	
No. of observations	2,211		2,211		2,211		2,211	
Pseudo R-sq	0.100		0.137		0.550		0.729	
Log likelihood	-1,281.766		-1,228.268		-641.399		-386.114	
LR chi-sq	284.525		391.521		1,565.261		2,075.829	

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01