

Evolution of Returns to Education in Colombia (1976-2014)

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Abstract

This document presents estimates of returns to education in Colombia, based on household surveys. Several econometric models are estimated and efforts have been made to correct possible selectivity biases. Our results indicate that during the last 40 years returns to education fluctuated within a fairly limited range (10.8% to 14.3%), which indicate a good deal of stability in spite of the significant changes that took place during that period. We also found that there is a large difference between post-secondary and pre-university returns, not only in their levels but also in their tendencies: pre-university education returns have been declining continuously, while post-secondary returns seem to have stabilized themselves around 20% since 1995.

Resumen

Este documento presenta estimativos de los retornos a la educación en Colombia, basados en encuestas a hogares. Se estiman varios modelos econométricos y se hacen esfuerzos para corregir el posible sesgo de selección. Nuestros resultados indican que en los últimos 40 años, los retornos a la educación fluctuaron en un rango bastante limitado (10,8% a 14,3%), lo cual indica una considerable estabilidad, a pesar de los cambios significativos que se dieron durante ese período. También encontramos que existe una gran diferencia entre los retornos post-secundaria y pre-universitaria, no solo en sus niveles sino también en sus tendencias: los retornos a la educación pre-universitaria han decrecido de manera continua, mientras que los retornos post-secundaria parecen haberse estabilizado alrededor del 20% desde 1995.

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Evolución de los retornos a la educación en Colombia (1976-2014)

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* The authors are: Chair of the Department, Associate professors (Álvarez and Gaviria) and research assistant in the Department of Economics of Universidad Jorge Tadeo Lozano (Bogotá). Although many authors have criticized the use of the expression "returns" to refer to educational premiums for reasons that we explain in section 4, we have decided to maintain it because it is still widely used in the literature. The authors want to thank Albert Berry, Dario Maldonado, Hugo Ñopo, and a number of participants in seminars in which we have presented this document for their valuable comments. The errors remaining are only our responsibility.

I. Introduction

Colombia has undergone a very significant expansion of the educational system during the last 50 years, and has also witnessed important changes in its institutions, its economic structure and its development policy orientation. All these factors have, most likely, affected the functioning of the labor market and have in turn been affected by it. To a very large extent the rates of return to education (an indicator of the market price of educational services) capture the relationship between the demand, generated by the economy, and the supply of those services, but, that we know of, no serious attempts have been made recently to evaluate the long run relationship between the evolution of the economy and the provision of educational services. This paper constitutes a contribution in that direction by providing series of returns to education on which such analysis can be based.

This article has seven parts. This first one is this introduction. In the second part a brief literature survey is presented. The third part reviews some basic information about Colombian labor markets considered relevant to understand the evolution of education returns. In the fourth part some technical and methodological aspects of the estimations are discussed. The fifth part discusses the data used and its limitations. In the sixth part the results of the estimations are presented and discussed. Finally the seventh part makes a brief summary of the most important findings.

II. Brief literature review for Colombia

Literature on returns to education in Colombia is fairly abundant. However, we restrict ourselves to the pieces that we consider the most representative of the type of work done in this area. One of the earliest attempts to estimate returns to education was made by Tenjo (1993) in which he analyzes the returns between 1976 and 1986 using the methodology of Mincer equations, combined with Spline Models to obtain different estimates for the returns to various levels of education. Returns are estimated both for men and women and also for salaried and independent workers. The author finds that average returns are higher for women than for men among wage workers, but it is not clear that there is a difference in the case of independent workers. In both cases the average returns decrease during the period of analysis. He does not find evidence of a statistically significant difference in returns between levels of education in the case of wage women but there is one for male wage workers. In the case of independent workers the situation is the opposite: women's returns are different for different educational levels, but no significant difference is found for men. The author explains the behavior of returns in terms of the labor force participation of women (which increased a great deal) and the increase in the amount of human capital (average number of years of education).

In a second article, Tenjo (1993-2) studies the bias on returns to education generated by missing vari-

ables such as individual ability. He used¹ a sample of 4000 workers in Bogotá to which individual ability (Progressive Raven Matrices) and knowledge tests were applied to measure their individual ability and educational quality, and those results are used as explanatory variables in (Mincerian) earnings equations. The results indicate that the no-inclusion of measures of ability and quality of education could overestimate the returns to education in around 1.5 percentage points.

Tenjo (1996) estimated a heterogeneity model to capture the effect of differences in individual abilities on the decisions to study beyond secondary education and its impact on returns to education. The model includes a post-secondary selectivity process based on individual ability and other characteristics of the individual (including financial resources). The results indicate that in general individuals who *select* themselves to undertake post-secondary education have higher returns to their investment than those who do not. Tenjo concludes that his is fairly strong evidence of the existence of meritocratic elements in the Colombian labor market.

Arias and Chaves (2002) use a methodology similar to that of Tenjo (1993) to analyze returns to education from a competitive perspective. They use a spline model with selectivity correction. The information comes from the household surveys covering the periods 1990-1995 (when several important

labor reforms took place) and 1999-2000 (years of very high unemployment). Their findings indicate that returns were higher for women than for men in both periods and that in 2000 returns fell, probably as a consequence of the economic recession.

Tenjo, Ribero and Bernat (2004) in a study comparing six Latin American countries (Argentina, Brazil, Colombia, Costa Rica, Honduras and Uruguay) estimated (mincerian) earnings equations for men and women (salaried and independent) correcting by selectivity bias for the period 1980-1998. In the case of Colombia they found that selectivity correction increased the estimates of returns to education for women and in some cases for men too. They also found that during the period of analysis the returns to education for women increased, but those for men went down. In all cases the returns were higher for women.

Forero and Gamboa (2006), estimate selectivity corrected mincerian equations for Bogotá, using DANE's Quality of Life surveys of 1997 and 2003. As in the case before, they found that selectivity correction increased the returns to education. However, the returns drop between the two years covered by their study. They attribute this result to the increase in unemployment which limited the bargaining position of unions and to the expansion of higher education in Bogotá which affected the relative position of more educated workers.

¹ The sample was collected by the Instituto SER de Investigación and financed by the University of Toronto.

Hernandez (2010) used information from the Ministry of Education's Observatorio Laboral para la Educación (OLE). This study includes as explanatory variables the degrees obtained by the person and a number of characteristics of the university and the program which the worker attended. As expected, incomes increase with the degree level (technical, professional, postgraduate, etc.), but the area of study and school characteristics also affected the results.

Montenegro and Patrinos (2014) use household surveys for several countries to estimate comparable rates of return covering the period 1970-2013. They used a mincerian model with dummy variables for different levels of education (primary, secondary and higher education). In their comparison they find that the African Sub-Saharan countries have the highest returns (12.4%). Latin America and East Asia have returns between 9.2% and 9.4%. And the lowest returns are in East Europe and South Asia (7.7%). They also find that returns have fallen during the last 30 years in about 3.5 percentage points.

III. Some aspects of the Colombian labor market during the period of analysis²

The two most important labor market developments in Colombia during the period of study are

the rapid growth of labor supply (especially for women) and the increase in the levels of education of the population.

A. Labor Supply

During the period of study Colombia was progressing along the advanced stages of the demographic transition, with rapidly declining rates of population growth. The Colombian Department of Statistics estimates that in the late 80s the annual growth rates for the population over 15 years of age in urban areas was above 2.75%, but by the end of the period they have reached an average 1.6%. This means that although demography was important in the early years of our period of analysis, towards the end other factors were probable more significant to explain the behavior of labor supply.

One of them was labor force participation, whose rates increased more or less continuously during the period (see Table 1, summarized in Figure 1).

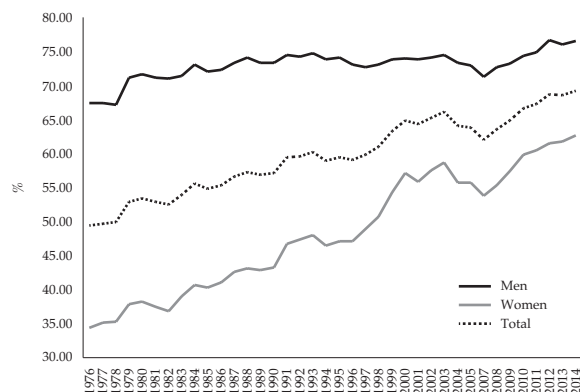
Figure 1 summarizes the evolution of participation rates between 1976 and 2014. On average these rates went up by about 20 percentage points between the beginning and the end of the period. Practically all the increase was due to the growth

² All the estimations presented in this paper are for the 7 main cities in Colombia and were estimated by the author using household surveys. See section V for a discussion of the data used.

Table 1
PARTICIPATION AND UNEMPLOYMENT RATES - 7 CITIES

Years	Participation Rates (%)			Unemployment Rates (%)		
	Men	Women	Total	Men	Women	Total
1976	67.38	34.37	49.38	9.68	11.56	10.40
1977	67.46	35.17	49.74	7.79	11.78	9.34
1978	67.14	35.34	49.88	6.81	10.13	8.09
1979	71.11	37.82	52.85	7.22	11.53	8.91
1980	71.64	38.30	53.42	7.56	11.61	9.15
1981	71.11	37.46	52.88	6.90	10.11	8.13
1982	70.95	36.79	52.56	8.03	12.03	9.53
1983	71.44	39.05	53.94	9.41	14.76	11.51
1984	73.03	40.66	55.53	11.06	16.61	13.26
1985	72.02	40.31	54.81	10.73	18.74	13.93
1986	72.30	41.12	55.37	10.17	17.27	13.03
1987	73.29	42.60	56.60	8.63	15.02	11.25
1988	74.05	43.11	57.23	7.74	13.74	10.20
1989	73.34	42.90	56.84	6.89	12.04	8.99
1990	73.34	43.28	57.19	8.14	13.21	10.21
1991	74.53	46.75	59.46	7.41	13.07	9.82
1992	74.20	47.36	59.54	6.54	12.56	9.15
1993	74.75	48.03	60.25	5.34	11.00	7.79
1994	73.86	46.40	58.98	4.89	11.21	7.58
1995	74.07	47.11	59.43	6.75	11.29	8.71
1996	73.12	47.09	59.07	9.58	15.06	11.94
1997	72.65	48.96	59.87	9.80	15.06	12.12
1998	73.01	50.75	60.95	12.49	17.99	14.97
1999	73.79	54.35	63.26	17.23	23.31	20.06
2000	73.97	57.11	64.86	16.94	24.47	20.52
2001	73.84	55.87	64.27	16.16	19.76	17.83
2002	74.04	57.48	65.23	16.23	20.37	18.17
2003	74.51	58.65	66.09	13.71	20.55	16.93
2004	73.32	55.77	64.01	12.37	17.09	14.55
2005	72.99	55.67	63.81	11.00	16.17	13.39
2007	71.30	53.80	62.05	9.52	12.38	10.83
2008	72.74	55.29	63.52	9.70	13.17	11.30
2009	73.25	57.34	64.85	10.85	14.47	12.54
2010	74.37	59.77	66.67	9.97	13.81	11.78
2011	74.91	60.41	67.26	8.47	11.91	10.10
2012	76.68	61.53	68.70	8.99	12.32	10.56
2013	76.08	61.77	68.54	7.80	11.65	9.62
2014	76.50	62.61	69.19	7.84	10.68	9.19

Figure 1
EVOLUTION OF PARTICIPATION RATES



in female participation, which went from 34.4% in 1976 to around 63% in 2014 (30 percentage points).

The rise in participation rates was more of less continuous during the 38 years, except for a significant drop between 2003 and 2007 (almost 5 percentage points in the case of women and more than 3 for men). Unfortunately no studies that investigate this behavior have been found³.

B. Average Years of Education

As indicated above, since the early 70s Colombia has been increasing the coverage of the educational

system. One way of seeing the results of these efforts is to look at the average years of education of the population.

The information about average years of education corresponds to 7 cities covered by the sources we are working with⁴, and is presented in Tables 3A and 3B. What the tables show is that levels of education have been increasing continuously since 1976, but at a faster pace for women than for men. For the working age population (12 years of age or more) the annual growth rate of years of education was around 1.2%, which is an important rate, considering that during the whole period the rate of population growth, although declining, was positive and still high (above 2%), so the educational system not only had to provide education for the new population, but also increase the levels of the population that already existed.

Table 2A presents information about levels of education for the population above 12 years of age, which clearly includes people who were out of the educational system, from the beginning of the period. The fact that it shows increases in the average number of years of education of more than 1% per year indicates that the expansion of the system was important, but it underestimates

³ One possible hypothesis is that the drop in participation rates after 2003, especially in those for women, is due to the *discouraged worker effect* associated with the high unemployment of previous years.

⁴ See section 5 on data sources, below.

Table 2A
AVERAGE YEARS OF SCHOOLING

Years	Working Age			Labor Force			Employed			Unemployed		
	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total
	1976	6.6	5.8	6.2	6.7	6.0	6.5	6.8	5.9	6.5	6.5	6.3
1977	6.8	6.0	6.3	6.9	6.3	6.7	6.9	6.2	6.7	6.8	6.6	6.7
1978	6.9	6.1	6.4	7.0	6.5	6.8	7.1	6.4	6.8	7.1	7.1	7.1
1979	6.9	6.1	6.5	7.1	6.7	6.9	7.1	6.6	6.9	7.1	7.2	7.1
1980	6.9	6.2	6.5	7.0	6.7	6.9	7.0	6.7	6.9	7.1	7.2	7.1
1981	7.2	6.5	6.9	7.4	7.2	7.3	7.4	7.1	7.3	7.1	7.7	7.4
1982	7.1	6.5	6.7	7.2	7.2	7.2	7.3	7.1	7.2	7.0	7.4	7.2
1983	7.1	6.6	6.8	7.3	7.3	7.3	7.4	7.3	7.3	7.2	7.6	7.4
1984	7.2	6.7	6.9	7.4	7.4	7.4	7.4	7.3	7.4	7.3	7.8	7.6
1985	7.2	6.7	7.0	7.4	7.6	7.5	7.4	7.6	7.5	7.3	7.9	7.6
1986	7.5	7.0	7.2	7.7	7.9	7.8	7.8	7.8	7.8	7.5	8.2	7.9
1987	7.5	7.0	7.3	7.7	7.9	7.8	7.7	7.9	7.8	7.8	8.3	8.1
1988	7.6	7.1	7.4	7.9	8.1	8.0	7.9	8.1	8.0	7.6	8.3	8.0
1989	7.8	7.3	7.6	8.1	8.3	8.2	8.1	8.3	8.2	7.9	8.6	8.3
1990	7.9	7.4	7.6	8.1	8.4	8.2	8.1	8.3	8.2	8.1	8.4	8.3
1991	7.9	7.5	7.7	8.2	8.5	8.3	8.2	8.5	8.3	7.8	8.6	8.2
1992	7.9	7.5	7.7	8.2	8.5	8.4	8.2	8.6	8.3	8.2	8.5	8.4
1993	8.0	7.6	7.8	8.2	8.6	8.4	8.3	8.6	8.4	8.0	8.5	8.3
1994	8.0	7.7	7.9	8.3	8.9	8.6	8.5	8.9	8.5	8.2	8.8	8.6
1995	8.1	7.8	7.9	8.4	8.9	8.6	8.5	8.9	8.6	8.4	9.1	8.8
1996	8.1	7.8	7.9	8.4	8.9	8.6	8.5	8.9	8.6	8.1	8.8	8.5
1997	8.3	8.0	8.1	8.6	9.1	8.8	8.6	9.1	8.8	8.4	9.1	8.8
1998	8.4	8.1	8.2	8.7	9.1	8.9	8.8	9.1	8.9	8.4	9.1	8.8
1999	8.4	8.1	8.3	8.8	9.1	8.9	8.8	9.1	8.9	8.5	9.1	8.8
2000	8.5	8.3	8.4	8.9	9.2	9.1	8.9	9.2	9.0	9.0	9.3	9.2
2001	8.7	8.4	8.5	9.1	9.4	9.2	9.1	9.4	9.2	8.8	9.6	9.2
2002	8.8	8.5	8.6	9.2	9.5	9.3	9.2	9.5	9.3	9.1	9.6	9.4
2003	8.8	8.6	8.7	9.3	9.5	9.4	9.2	9.5	9.4	9.5	9.7	9.6
2004	9.0	8.8	8.9	9.5	9.8	9.6	9.5	9.8	9.6	9.5	9.9	9.7
2005	9.1	8.9	9.0	9.6	10.0	9.8	9.6	10.0	9.8	9.8	10.2	10.0
2007	9.2	9.0	9.1	9.8	10.2	10.0	9.8	10.2	10.0	9.8	10.5	10.2
2008	9.3	9.1	9.2	9.9	10.4	10.1	9.9	10.4	10.1	10.0	10.6	10.3
2009	9.2	9.1	9.1	9.8	10.2	10.0	9.8	10.3	10.0	9.7	10.2	10.0
2010	9.3	9.2	9.3	9.9	10.3	10.1	9.8	10.2	10.0	10.1	10.5	10.3
2011	9.4	9.3	9.4	10.0	10.4	10.2	10.0	10.5	10.2	10.2	10.4	10.3
2012	9.5	9.4	9.4	10.1	10.5	10.3	10.0	10.5	10.2	10.3	10.6	10.5
2013	9.7	9.5	9.6	10.3	10.7	10.5	10.3	10.7	10.5	10.5	10.8	10.6
2014	9.7	9.6	9.6	10.3	10.8	10.5	10.2	10.8	10.5	10.5	10.9	10.7
Annual growth (%)	1.00	1.36	1.19	1.11	1.57	1.29	1.10	1.58	1.29	1.27	1.46	1.36

Table 2B
AVERAGE YEARS OF SCHOOLING OF POPULATION BETWEEN 30 AND 35 YEARS OF AGE

Years	Working Age			Labor Force			Employed			Unemployed		
	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total
	1976	7.6	5.8	6.6	7.6	6.4	7.1	7.6	6.4	7.2	6.8	5.4
1977	7.4	6.2	6.8	7.5	6.8	7.2	7.5	6.8	7.3	6.8	5.7	5.7
1978	7.7	6.2	6.8	7.7	6.8	7.4	7.7	6.9	7.4	6.8	5.6	6.1
1979	8.0	6.4	7.1	8.0	6.9	7.6	8.0	7.0	7.6	7.6	6.4	6.9
1980	7.9	6.5	7.2	7.9	7.1	7.6	7.9	7.2	7.6	7.6	6.0	6.8
1981	8.0	7.0	7.5	8.1	7.7	7.9	8.1	7.8	8.0	7.5	7.5	7.4
1982	7.9	7.0	7.4	7.9	7.8	7.9	8.0	7.9	8.0	6.6	6.6	6.6
1983	8.1	7.1	7.6	8.1	7.8	8.0	8.1	7.9	8.0	7.8	6.6	7.3
1984	8.1	7.3	7.7	8.1	8.1	8.1	8.2	8.2	8.2	7.2	7.5	7.3
1985	8.4	7.6	7.9	8.4	8.4	8.4	8.5	8.6	8.5	7.3	7.4	7.4
1986	8.5	7.8	8.1	8.6	8.5	8.6	8.6	8.6	8.6	8.0	8.0	8.0
1987	8.4	8.0	8.2	8.5	8.8	8.6	8.5	8.8	8.6	8.5	8.4	8.5
1988	8.7	8.1	8.4	8.8	8.9	8.8	8.8	8.9	8.9	7.9	8.4	8.2
1989	8.8	8.4	8.6	8.8	9.2	9.0	8.9	9.3	9.0	8.0	8.6	8.3
1990	9.0	8.4	8.6	9.0	9.1	9.0	9.1	9.2	9.1	8.5	8.1	8.3
1991	9.1	8.7	8.8	9.1	9.2	9.2	9.1	9.3	9.2	8.5	8.4	8.4
1992	8.9	8.8	8.8	8.9	9.5	9.2	9.0	9.5	9.2	8.6	9.0	8.9
1993	9.0	8.7	8.9	9.1	9.2	9.1	9.1	9.4	9.2	8.5	7.9	8.1
1994	9.1	8.8	9.0	9.1	9.5	9.3	9.2	9.6	9.4	8.4	8.6	8.5
1995	9.0	9.0	9.0	9.1	9.5	9.3	9.1	9.6	9.3	8.9	9.0	9.0
1996	9.2	9.0	9.1	9.3	9.7	9.4	9.3	9.8	9.5	8.7	8.7	8.7
1997	9.3	9.3	9.3	9.4	9.9	9.7	9.4	10.0	9.7	9.4	9.1	9.2
1998	9.3	9.2	9.2	9.3	9.7	9.5	9.3	9.8	9.5	8.8	9.2	9.1
1999	9.5	9.2	9.3	9.4	9.7	9.5	9.5	9.8	9.6	8.8	9.2	9.1
2000	9.5	9.6	9.5	9.5	10.0	9.7	9.5	10.1	9.8	9.4	9.4	9.4
2001	9.6	9.5	9.5	9.7	9.9	9.8	9.7	10.0	9.9	8.9	9.5	9.3
2002	9.9	9.9	9.9	10.0	10.3	10.2	10.1	10.3	10.2	9.8	10.1	10.0
2003	10.0	9.8	9.9	10.0	10.2	10.1	10.1	10.3	10.2	9.9	9.7	9.8
2004	10.0	10.0	10.0	10.0	10.4	10.2	10.0	10.5	10.3	10.1	9.8	9.9
2005	10.2	10.2	10.2	10.2	10.7	10.4	10.2	10.7	10.5	10.1	10.2	10.2
2007	10.3	10.5	10.4	10.5	10.9	10.7	10.5	11.0	10.7	10.6	10.8	10.7
2008	10.6	10.8	10.7	10.8	11.3	11.0	10.8	11.3	11.1	10.3	11.1	10.8
2009	10.5	10.8	10.6	10.5	11.2	10.8	10.6	11.3	10.9	10.2	10.4	10.3
2010	10.8	11.0	10.9	10.9	11.3	11.1	10.9	11.4	11.1	10.8	10.8	10.8
2011	10.9	11.2	11.1	11.0	11.6	11.3	11.0	11.7	11.3	10.9	10.8	10.8
2012	11.1	11.3	11.2	11.2	11.6	11.4	11.2	11.7	11.4	11.0	11.0	11.1
2013	11.2	11.6	11.4	11.3	11.9	11.6	11.3	12.0	11.6	11.1	11.2	11.2
2014	11.3	11.8	11.6	11.4	12.1	11.7	11.4	12.1	11.7	11.4	11.5	11.4
Annual growth (%)	1.05	1.87	1.48	1.07	1.70	1.31	1.06	1.69	1.29	1.39	2.00	1.67

the actual increase. A better estimate is presented in Table 2B, which shows the average years of education of the cohort between 30 and 35 years of age. The annual growth rates in this table are much higher than the ones estimated in Table 2A, especially in the case of women. For the cohort of women between 30 and 35 years the average number of years of education increased at an annual rate of 1.87%. Although not so high, the rates of female labor force participants (employed and unemployed) were also significant. The growth rates were much smaller (except in the case of unemployed workers).

The conclusion that one could derive from this information is that the supply of human capital in the market, particularly that of female workers, increased substantially between 1976 and 2014. At the beginning of the period women in the 30 to 35 years of age cohort had between one and two years of education less than men, ten years later labor force participants (men and women) had about the same amount of education; by the end of the period of study (2014) employed and labor force women had one year more of education than men.

It is also interesting to point out that the group that has had the fastest increase in years of education is that of unemployed workers of the same cohort which raises some questions about the capacity of the economy to absorb the increased human capital.

C. Unemployment

During the period studied the economy has had rates of unemployment that are high for international standards. The average rate was 11.7%, and fluctuated between 7.6% and 20.5%. The information is presented in Table 1 (last three columns) and summarized in Figure 2.

Figure 2
EVOLUTION OF UNEMPLOYMENT RATES



Loosely speaking, the period covers two economic cycles. The last one, at the end of the 20th century, is the most serious recession of Colombia's recent history. If one ignores the little spur of unemployment in 2007-2009, the recovery since 2000 has been the longest in the recent history.

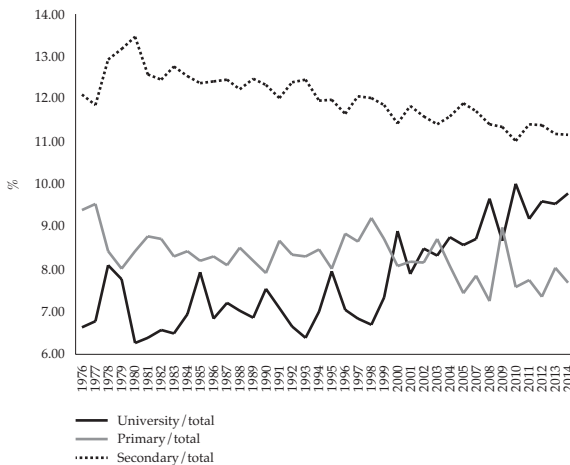
Regardless of the phase of the economy, the unemployment rates for women have always been higher than those for men and the gaps tend to be higher at the beginning of the recovery periods.

Table 3
UNEMPLOYMENT BY LEVELS OF EDUCATION

Years	Unemployment Rates (%)				Rates as a Proportion of Total Unemployment				
	None	Primary	Secondary	University	Total	None	Primary	Secondary	University
1976	7.29	9.76	12.58	6.91	10.40	0.7012	0.9387	1.2102	0.6644
1977	5.63	8.90	11.08	6.33	9.34	0.8890	0.9529	1.1862	0.6781
1978	3.51	6.81	10.47	6.55	8.09	0.5351	0.8419	1.2939	0.8102
1979	5.40	7.15	11.75	6.91	8.91	0.7807	0.8020	1.3178	0.7757
1980	4.48	7.71	12.31	5.73	9.15	0.7809	0.8431	1.3463	0.6266
1981	5.20	7.13	10.22	5.19	8.13	1.0020	0.8772	1.2575	0.6380
1982	6.97	8.31	11.87	6.27	9.53	1.1113	0.8714	1.2456	0.6581
1983	8.32	9.56	14.68	7.47	11.51	1.1140	0.8308	1.2760	0.6489
1984	7.99	11.16	16.63	9.19	13.26	0.8688	0.8419	1.2545	0.6934
1985	9.26	11.42	17.25	11.05	13.93	0.8381	0.8201	1.2384	0.7934
1986	9.03	10.81	16.19	8.91	13.03	1.0132	0.8293	1.2424	0.6839
1987	6.42	9.13	14.04	8.14	11.27	0.7889	0.8103	1.2459	0.7221
1988	6.06	8.68	12.48	7.18	10.20	0.8441	0.8510	1.2229	0.7035
1989	6.11	7.39	11.23	6.18	9.00	0.9885	0.8206	1.2470	0.6865
1990	8.05	8.10	12.64	7.72	10.24	1.0433	0.7909	1.2342	0.7536
1991	7.51	8.54	11.85	6.98	9.85	1.0764	0.8662	1.2029	0.7084
1992	6.82	7.70	11.45	6.14	9.23	1.1103	0.8342	1.2405	0.6653
1993	4.09	6.47	9.73	4.99	7.80	0.8201	0.8295	1.2467	0.6395
1994	8.03	6.43	9.09	5.32	7.60	1.5107	0.8460	1.1967	0.7001
1995	4.55	6.99	10.45	6.94	8.73	0.6560	0.8008	1.1976	0.7954
1996	12.06	10.58	13.96	8.43	11.97	1.4315	0.8842	1.1664	0.7044
1997	9.89	10.49	14.62	8.28	12.11	1.1938	0.8660	1.2070	0.6837
1998	11.81	13.78	18.01	10.04	14.99	1.1755	0.9197	1.2015	0.6701
1999	16.62	17.54	23.86	14.75	20.11	1.1266	0.8721	1.1864	0.7333
2000	17.19	16.63	23.52	18.31	20.58	0.9393	0.8080	1.1430	0.8897
2001	13.85	14.60	21.13	14.10	17.86	0.9828	0.8172	1.1830	0.7890
2002	12.57	14.92	21.18	15.51	18.27	0.8106	0.8166	1.1592	0.8489
2003	16.22	14.82	19.39	14.15	17.00	1.1463	0.8718	1.1407	0.8323
2004	11.15	11.85	17.01	12.83	14.66	0.8688	0.8079	1.1602	0.8751
2005	9.27	10.00	16.00	11.51	13.44	0.8057	0.7444	1.1907	0.8566
2007	8.68	8.50	12.70	9.43	10.83	0.9206	0.7845	1.1726	0.8704
2008	7.83	8.19	12.90	10.91	11.30	0.7182	0.7246	1.1415	0.9650
2009	8.74	11.26	14.23	10.89	12.54	0.8029	0.8975	1.1342	0.8681
2010	9.89	8.93	12.98	11.80	11.79	0.8388	0.7572	1.1013	1.0008
2011	10.91	7.82	11.51	9.28	10.10	1.1760	0.7742	1.1399	0.9185
2012	9.52	7.76	12.02	10.13	10.56	0.9398	0.7346	1.1378	0.9590
2013	7.40	7.74	10.77	9.17	9.63	0.8071	0.8040	1.1188	0.9530
2014	7.40	7.06	10.27	8.99	9.19	0.8228	0.7677	1.1168	0.9779

It is also important to know what happened with the rates of unemployment by levels of education. The information is presented in Table 3 and a summary of it can be seen in Figure 3, below.

Figure 3
UNEMPLOYMENT BY LEVELS OF EDUCATION
AS A PROPORTION OF TOTAL
UNEMPLOYMENT



This figure presents the evolution of relative unemployment by levels of education (unemployment rates of each level divided by the total unemployment rate), which is a way of seeing the changes in the ability of different groups to insert themselves in the labor market without the interference of the business cycle.

As it is well known, the highest unemployment is found among those with secondary education,

while those with low levels of education and university educated people have lower unemployment (the inverted-U relationship between education and unemployment). However, Figure 3 shows two important things: one is the rapid decline of the relative unemployment rate of secondary education and the second one is the increase in that of people with university education, starting around 2000. During the last 15 years the two rates have converged rapidly and in 2014 the difference was very small.

It is interesting to see how these relative unemployment measures behave in the case of men and women. The information is presented in Tables 4A and 4B, and summarized in Figures 4A and 4B below.

In the case of men there is a lot of volatility but the tendencies are fairly clear: the relative unemployment of males with secondary education declined during the whole period studied, while the relative rates of men with university education increased rather rapidly since the beginning of the century. This seems to imply that educated males have been having increasing difficulties in finding jobs, but there are many factors, both on the supply and in the demand sides, that could explain this phenomenon.

In the case of women we observe more or less the same tendencies, but much less pronounced.

Table 4A
MALE UNEMPLOYMENT BY EDUCATIONAL GROUPS

Years	Unemployment Rates (%)						Relative Rates*				
	None	Primary	Secondary	University	Total	None	Primary	Secondary	University	Relative Rates*	
										Primary	Secondary
1976	9.08	9.40	11.04	6.83	9.68	0.9376	0.9702	1.1405	0.7050		
1977	5.60	7.41	9.20	5.38	7.79	0.7191	0.9510	1.1810	0.6908		
1978	4.13	6.17	8.13	5.76	6.82	0.6064	0.9049	1.1925	0.8456		
1979	5.37	6.46	8.72	5.69	7.22	0.7430	0.8944	1.2073	0.7870		
1980	5.39	6.55	9.82	5.05	7.56	0.7125	0.8664	1.2981	0.6677		
1981	6.87	6.66	8.03	4.21	6.90	0.9957	0.9652	1.1645	0.6110		
1982	8.31	7.32	9.62	5.00	8.03	1.0352	0.9125	1.1993	0.6234		
1983	8.17	8.39	11.61	5.78	9.41	0.8685	0.8911	1.2339	0.6141		
1984	9.26	10.21	13.02	7.67	11.06	0.8376	0.9235	1.1775	0.6937		
1985	10.23	9.58	12.59	8.30	10.73	0.9536	0.8929	1.1733	0.7734		
1986	8.34	9.35	12.01	6.83	10.17	0.8203	0.9194	1.1810	0.6718		
1987	8.15	7.74	10.08	6.41	8.65	0.9428	0.8944	1.1653	0.7407		
1988	5.83	7.41	8.87	5.41	7.75	0.7523	0.9569	1.1441	0.6980		
1989	9.39	6.16	9.58	4.44	6.90	1.3610	0.8934	1.1916	0.6438		
1990	8.02	6.83	9.58	6.74	8.17	0.9809	0.8356	1.1721	0.8250		
1991	9.04	7.21	8.50	4.68	7.42	1.2178	0.9710	1.1444	0.6304		
1992	6.35	5.98	4.67	7.70	6.58	0.9644	0.9088	1.1697	0.7093		
1993	3.77	4.71	6.48	3.36	5.34	0.7062	0.8818	1.2122	0.6282		
1994	6.14	4.73	5.61	3.02	4.89	1.2556	0.9665	1.1469	0.6162		
1995	6.66	5.94	7.71	5.45	6.78	0.9833	0.8763	1.1376	0.8045		
1996	13.92	9.31	10.76	6.07	9.57	1.4545	0.9729	1.1244	0.6347		
1997	7.94	9.88	11.01	6.96	9.80	0.8105	1.0085	1.1235	0.7106		
1998	11.77	13.08	14.18	8.33	12.50	0.9420	1.0469	1.1349	0.6664		
1999	16.51	16.42	19.57	13.06	17.26	0.9562	0.9509	1.1336	0.7567		
2000	15.01	14.28	18.52	16.60	16.99	0.8839	0.8406	1.0903	0.9772		
2001	15.91	14.25	18.41	13.29	16.21	0.9812	0.8791	1.1354	0.8198		
2002	11.14	13.32	18.63	14.58	16.34	0.6814	0.8150	1.1400	0.8924		
2003	13.09	12.77	15.29	11.65	13.74	0.9524	0.9292	1.1121	0.8473		
2004	8.48	10.78	13.74	11.77	12.48	0.6801	0.8642	1.1015	0.9430		
2005	6.82	9.51	12.38	9.95	11.04	0.6179	0.8612	1.1217	0.9013		
2007	10.79	8.32	10.71	8.23	9.52	1.1335	0.8742	1.1248	0.8648		
2008	8.75	7.50	10.65	9.63	9.71	0.9016	0.7730	1.0972	0.9919		
2009	6.95	10.19	11.75	9.95	10.86	0.6405	0.9390	1.0821	0.9167		
2010	10.51	7.68	10.17	11.11	9.97	1.0543	0.7702	1.0201	1.1148		
2011	10.16	7.28	8.91	8.41	8.47	1.2002	0.8603	1.0517	0.9930		
2012	8.79	6.53	10.14	8.69	8.99	0.9776	0.7260	1.1277	0.9661		
2013	7.02	6.77	8.34	7.61	7.80	0.8996	0.8683	1.0694	0.9758		
2014	5.65	6.17	8.41	8.06	7.84	0.7202	0.7864	1.0721	1.0281		

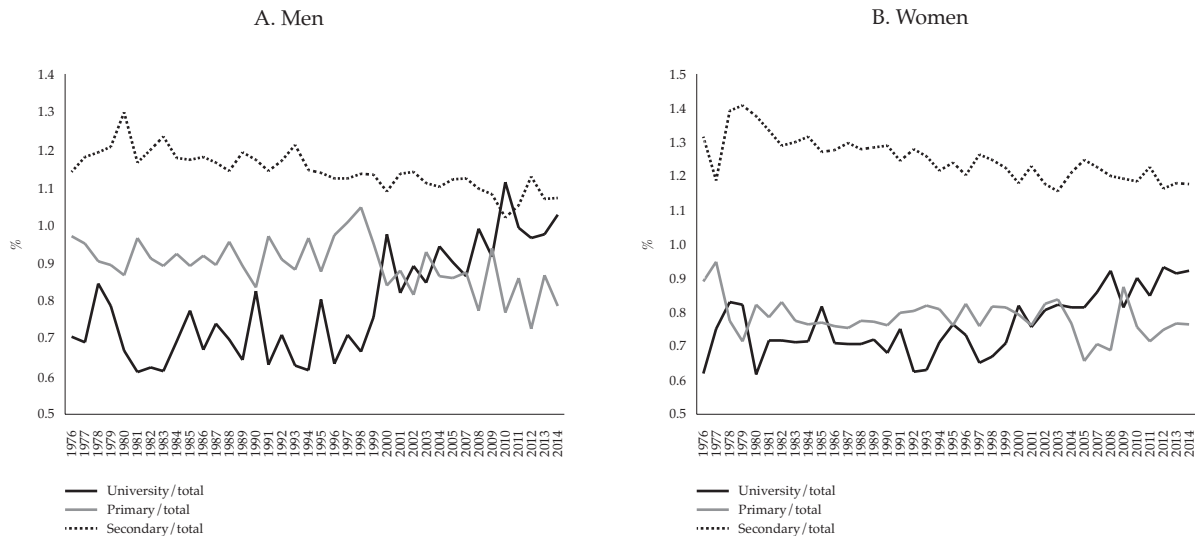
* Relative rate_i = rate group_i / total.

Table 4B
FEMALE UNEMPLOYMENT BY EDUCATIONAL GROUPS

Years	Unemployment Rates (%)					Relative Rates*				
	None	Primary	Secondary	University	Total	None	Primary	Secondary	University	University
1976	5.62%	10.30%	15.22%	7.16%	11.56%	0.4861	0.8905	1.3159	0.6191	0.6191
1977	5.65%	11.17%	14.00%	8.84%	11.78%	0.4796	0.9478	1.1878	0.7498	0.7498
1978	2.98%	7.84%	14.08%	8.39%	10.13%	0.2946	0.7742	1.3905	0.8289	0.8289
1979	5.42%	8.23%	16.25%	9.48%	11.53%	0.4704	0.7133	1.4087	0.8222	0.8222
1980	3.58%	9.54%	15.97%	7.16%	11.61%	0.3082	0.8221	1.3760	0.6167	0.6167
1981	3.54%	7.92%	13.48%	7.25%	10.11%	0.3505	0.7841	1.3342	0.7172	0.7172
1982	5.41%	9.98%	15.49%	8.61%	12.03%	0.4500	0.8300	1.2882	0.7160	0.7160
1983	8.48%	11.45%	19.21%	10.51%	14.76%	0.5743	0.7758	1.3010	0.7117	0.7117
1984	6.66%	12.69%	21.84%	11.87%	16.61%	0.4012	0.7637	1.3145	0.7142	0.7142
1985	8.00%	14.44%	23.82%	15.29%	18.74%	0.4270	0.7702	1.2711	0.8159	0.8159
1986	9.77%	13.12%	22.05%	12.24%	17.27%	0.5654	0.7596	1.2764	0.7085	0.7085
1987	4.60%	11.34%	19.54%	10.62%	15.06%	0.3058	0.7533	1.2972	0.7052	0.7052
1988	6.28%	10.63%	17.58%	9.71%	13.74%	0.4570	0.7735	1.2793	0.7067	0.7067
1989	2.73%	9.29%	15.45%	8.65%	12.04%	0.2267	0.7717	1.2832	0.7186	0.7186
1990	8.09%	10.10%	17.08%	9.03%	13.25%	0.6102	0.7618	1.2884	0.6812	0.6812
1991	6.00%	10.47%	16.35%	9.84%	13.12%	0.4573	0.7977	1.2457	0.7502	0.7502
1992	7.39%	10.19%	16.21%	7.92%	12.69%	0.5826	0.8035	1.2776	0.6239	0.6239
1993	4.45%	9.05%	13.88%	6.94%	11.03%	0.4038	0.8206	1.2586	0.6298	0.6298
1994	10.57%	9.07%	13.65%	7.99%	11.23%	0.9411	0.8076	1.2153	0.7115	0.7115
1995	2.41%	8.62%	14.01%	8.63%	11.30%	0.2134	0.7622	1.2395	0.7630	0.7630
1996	9.92%	12.46%	18.20%	11.10%	15.14%	0.6556	0.8234	1.2021	0.7333	0.7333
1997	12.24%	11.42%	18.99%	9.80%	15.04%	0.8133	0.7591	1.2622	0.6512	0.6512
1998	11.84%	14.73%	22.49%	12.06%	18.02%	0.6574	0.8178	1.2486	0.6692	0.6692
1999	16.73%	19.01%	28.63%	16.57%	23.38%	0.7156	0.8130	1.2245	0.7086	0.7086
2000	19.79%	19.47%	28.92%	20.08%	24.53%	0.8067	0.7936	1.1789	0.8187	0.8187
2001	12.00%	15.04%	24.30%	14.95%	19.78%	0.6065	0.7604	1.2287	0.7560	0.7560
2002	14.18%	16.87%	24.05%	16.51%	20.45%	0.6932	0.8247	1.1758	0.8071	0.8071
2003	19.60%	17.28%	23.84%	16.99%	20.65%	0.9492	0.8368	1.1545	0.8229	0.8229
2004	14.20%	13.21%	20.82%	13.99%	17.21%	0.8253	0.7680	1.2098	0.8129	0.8129
2005	11.79%	10.64%	20.22%	13.19%	16.22%	0.7266	0.6562	1.2463	0.8133	0.8133
2007	5.35%	8.73%	15.19%	10.62%	12.38%	0.4322	0.7051	1.2268	0.8581	0.8581
2008	6.88%	9.06%	15.82%	12.15%	13.18%	0.5225	0.6878	1.2009	0.9224	0.9224
2009	10.91%	12.64%	17.26%	11.77%	14.47%	0.7542	0.8737	1.1931	0.8134	0.8134
2010	8.98%	10.45%	16.36%	12.43%	13.81%	0.6501	0.7568	1.1845	0.9004	0.9004
2011	11.76%	8.50%	14.61%	10.11%	11.92%	0.9865	0.7132	1.2257	0.8480	0.8480
2012	10.49%	9.21%	14.34%	11.49%	12.32%	0.8514	0.7475	1.1639	0.9324	0.9324
2013	7.90%	8.92%	13.75%	10.64%	11.65%	0.6784	0.7657	1.1801	0.9130	0.9130
2014	10.11%	8.16%	12.56%	9.84%	10.68%	0.9461	0.7641	1.1760	0.9208	0.9208

* Relative rate_i = rate group_i / total.

Figure 4
RELATIVE UNEMPLOYMENT RATES BY LEVELS OF EDUCATION



IV. Some Theoretical Considerations for the Estimation of Returns to Education

The most common form of estimating returns to education is using the well-known equation of Mincer, which associates the labor earnings of a person with his/her amount of human capital, measured by the years of schooling and the experience accumulated. This relationship can be summarized in the following equation:

$$\ln(y_i) = \beta_0 + \beta_1 S_i + \beta_2 X_i + \beta_3 X_i^2 + \beta_4 Sex_i + \epsilon_i \quad (1A)$$

where y_i is a measure of individual i 's income, X is a vector of measures of human capital (such as

years of schooling, S , and experience, X) and ϵ is an error term, assumed to have the usual characteristics (normally distributed with zero mean and constant variance).

The returns to education are given by

$$\text{Returns to education} = \frac{\delta y}{\delta s} \frac{1}{y} = \beta_1 \quad (1B)$$

This model has been criticized on several grounds: one is the implicit assumption that the only private cost of education is the opportunity cost, which could be inappropriate in some contexts. Another one is that associated with a possible selectivity bias caused by the lack of randomness of the samples used to estimate returns. A third

line of criticism has to do with the measurement of schooling, which implies the accumulation of different types of education (adding apples and oranges), and the fact that some important explanatory variables are not usually included because they are difficult to observe and measure (such as individual ability and quality of education). To the extent that schooling captures the effect of these unobserved variables, the returns to education measured by the Mincerian equation are positively biased (overestimate the real returns).

There are solutions to many of these problems. For example there are many techniques to correct for selectivity problems, but they all depend on how well we are able to simulate the selectivity processes, about which we do not know very much.

Given the purpose of this study, which is to understand the general tendencies in returns to education in Colombia, we could start with the assumption that the correction of these biases is not a priority, either because the size of the bias remains more or less constant through time, or because it does not change enough to affect the general direction of the returns estimated using Mincer's model. This assumption, however, will be revised later on to investigate the possibility that unemployment affects the size of the selection bias.

Unfortunately, there are no satisfactory solutions to the problems created by the lack of some relevant variables in the equation (such as ability and quality of education). Although there are econometric techniques to deal with this problem (instrumental variables, for example), the lack of adequate information is a serious limitation.⁵

More specifically, we estimated returns to education for the period 1976-2014, using the following models:

- The **mincerian** model presented in equation (1)
- A **selectivity corrected mincerian** equation.

In general mincerian equations are estimated with samples of employed workers. Non participants and unemployed workers are excluded, regardless of their educational levels. Given that the period of analysis is a long one and includes at least two unemployment peaks (in 1985 and 2000), the assumption that the size of the bias generated by not correcting the selectivity of the sample remained constant does not hold.

The problem is that for a person to be in the sample of employed workers it has to undergo a double selectivity process, one is that associ-

⁵ In the case of instrumental variables it would be necessary to find consistent instruments for the whole period of analysis, which is not easy to do.

ated with the decision to participate in the labor market and the other associated to the outcome of being employed (given that he/she decided to participate).

The way we handled this double selectivity process was the following:

- Employment equations corrected for participation selectivity were estimated. From these equations we estimated the probability that a person is employed, given that the person participates in the labor market. $P(\text{Employed} \mid \text{participates})$.
- With these conditional predicted probabilities we estimated the inverse of the mill's ratio and use it in the earnings equation.

More specifically, we estimated the following model

$$\ln(y_i) = \beta_0 + \beta_1 S_i + \gamma D_i(S_i - 11) + \beta_2 X_i + \beta_3 X_i^2 + \beta_4 Sex_i + \alpha_i \lambda_i + \varepsilon_i \quad (2)$$

where $\lambda_i = \frac{\phi(Z_i)}{1 - \phi(Z_i)}$

is the inverse of the mill 's ratio; $\phi(Z)$ is the predicted probability of being employed given that the person participates in the labor market $P(E \mid \text{part} = 1)$ and ϕ is the corresponding density function. The prediction of $P(E \mid \text{part} = 1)$ was made correcting the selectivity bias generated by the decision to

participate. Z is a transformation of the variables that explain the probability of being employed.

- Another model used in the estimation was a Spline model, which allows us to estimate different returns to different levels of education. More specifically, with this model it is possible to capture differences in the returns between primary and secondary education on the one hand and post-secondary education on the other.

The Spline model used in the estimation has the following structure:

$$\ln(y_i) = \beta_0 + \beta_1 S_i + \gamma D_i(S_i - 11) + \beta_2 X_i + \beta_3 X_i^2 + \beta_4 Sex_i + \varepsilon_i \quad (3A)$$

Where D_i is a dummy variable equal to 1 if $S_i > 11$, and zero otherwise, and γ can be interpreted as a market premium associated to having post-secondary education. The returns to pre-university education and post-secondary education are respectively given by:

$$\frac{\delta y}{\delta s} \frac{1}{y} = \beta_1 \quad \text{and} \quad \frac{\delta y}{\delta s} \frac{1}{y} = \beta_1 + \gamma \quad (3B)$$

As indicated above, the information available after 2006 makes it possible to include the effect of degrees (technical and professional). This allows us divide the premium to post-secondary education (γ) in two: one to just having post-secondary education without a degree (γ_1) and another one (γ_2) which will be a premium to having a professional

degree. The structure of the regression model for this estimation is the following:

$$\ln(y_i) = \beta_0 + \beta_1 S_i + \gamma_1 D_i(S_i - 11) + \gamma_2 D_i K_i(S_i - 11) + \beta_2 X_i + \beta_3 X_i^2 + \beta_4 Sex_i + \varepsilon_i \quad (4A)$$

where K_i is a dummy variable equal to 1 if the person observed has a professional degree and zero otherwise.

The returns to post-secondary education without and with a professional degree are given respectively by:

$$\frac{\delta y}{\delta s} \frac{1}{y} = \beta_1 + \gamma_1 \quad \text{and} \quad \frac{\delta y}{\delta s} \frac{1}{y} = \beta_1 + \gamma_1 + \gamma_2 \quad (3B)$$

The same selectivity correction used for mincerian estimates were applied to spline regressions to produce corrected and uncorrected returns to pre-university and post-secondary education.

□ Finally, quintile regressions models were used to differentiate segments of the distribution of labor income and evaluate whether the evolution of the returns was similar for all of them. One criticism to the estimation of mincerian returns (corrected for selection bias or not) is that they represent average returns for the population as a whole. The Spline model estimates returns for different levels of education

(which are correlated with labor income), but does not answer the question of whether the average returns are a good estimate for all the segments of the income distribution.

Quintile regression methods are an approach that allows us to answer these type of questions. This technique permits to estimate returns to education for different percentiles of the distribution of labor income. Since the maximization techniques are different (quintile regression minimizes the sum of absolute differences, while regular regression minimizes squared differences), the results are not exactly comparable with the mincerian ones, but the point here is not to make that type of comparisons but to see the dispersion of returns for different segments of the distribution.

V. Statistical Information Used in the Empirical Analysis

The information used in this exercise comes from the Colombian household surveys collected by the Colombian Department of Statistics (DANE).⁶ The surveys provide abundant information about individual characteristics (Sex, age, amount of education, marital status, family position, labor market participation, employment situation, labor and other type of earnings, etc.). Many methodological

⁶ The Household Survey project started in 1970, but surveys are available only from 1976.

changes have been introduced through the years, but the most important ones, which could affect seriously the comparability of our estimates, happened in 2000 and 2006. These changes divide the period on analysis in three sub-periods:

1976-2000

During this period the surveys were collected quarterly and covered only the 7 most important cities in the country, namely: Bogotá, Medellín, Cali, Barranquilla, Manizales, Pereira, and Bucaramanga. We used the information for the third quarter of every year (months of July, August and September).

2001-2005

In the year 2000 DANE made important improvements in the surveys. One of them is to make the survey continuous (information would be collected every day, not every three months), which allow it to produce monthly results for the largest cities in the country. It also increased the size of the samples and the area covered by the surveys. New questions were included and others were changed and refined. In this occasion DANE made parallel surveys with the new and old methodologies to compare results and found that the difference in terms of unemployment rates was about one percentage point (lower with the new methodology). No other variables were compared.

These changes probably improved the quality of information by a great deal but might affect com-

parisons with previous estimates. We maintain the same 7 cities in our estimates and continue working with the information for the third quarter of each years, but there is little else one can do.

2006-2014

In 2006 DANE introduced a new methodology in household surveys and created the Integrated Household Surveys. Again the area covered was increased, some questions were reformulated, new questions were introduced and sample sized was augmented. Unfortunately in this case there were no parallel surveys collected (with the new and old methodologies). Aggregate results between the pre-2006 and the post-2006 estimates of various variables were compared and some adjustments were made, but inconsistencies in the 2006 surveys were too big to be used in this document. For that reason this year was excluded from our estimates.

For the rest of the period (2002-2014) we estimate returns for the 7 cities used in the previous ones using the third quarter for each year.

The definitions of the variables used in the regressions are as follows:

- Hourly labor income. It includes income both for wage workers and independent workers. It includes domestic servants, but excludes other workers such as employers, day laborers (*peones*), and unpaid family workers. It was estimated adding all the sources of labor income

(converted to monthly income) and dividing by the number of hours worked in the month. In turn, this number of monthly hours was estimated assuming that the hours worked in the week previous to the interview (which is the information collected by the surveys) applied to the whole month.

- Schooling (years of) was estimated adding up the number of complete years of primary, secondary and university declared by the worker. It was assumed that complete pre-university education was 11 years, so the workers for whom the sum of primary plus secondary was higher than eleven, were adjusted to that number.⁷
- Since the household surveys do not have a consistent measure of experience that covers all the period of analysis we use *potential experience*, defined as age minus education minus 5, assuming that kids enter primary education at the age of five.

VI. Some Important Findings from the Empirical Analysis

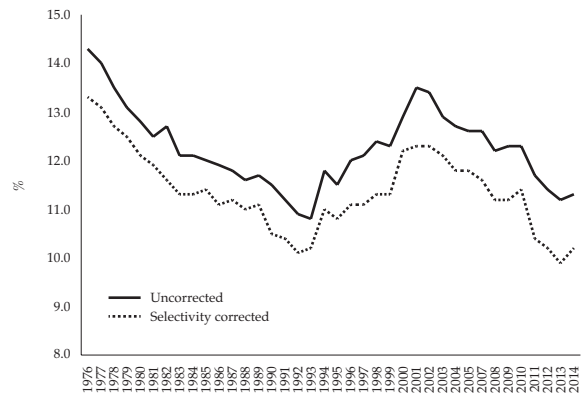
As indicated above, a great number of models were run and the most important results are included in

the appendix. Here we concentrate in the analysis of the returns to education. It is important to mention, however, that all the estimates on which our analysis is based were very significant and robust. Specially, the different estimates of returns to education had statistically significant levels of 1% or more.

A. Mincer Equations

A summary of the returns to education estimated using Mincer's model (denominated here *mincerian returns*) is presented in Table 5. A summary is presented in Figure 5 below. Some of the most important results are the following:

Figure 5
MINCIERIAN RETURNST
TO EDUCATION



⁷ For a very small number of workers that studied the so call *technical secondary* education, or some students of international schools the sum of primary and secondary years could be 12 or 13 years. I these students have some years of university education their total years of schooling was estimated assuming that their pre-university education was only 11 years.

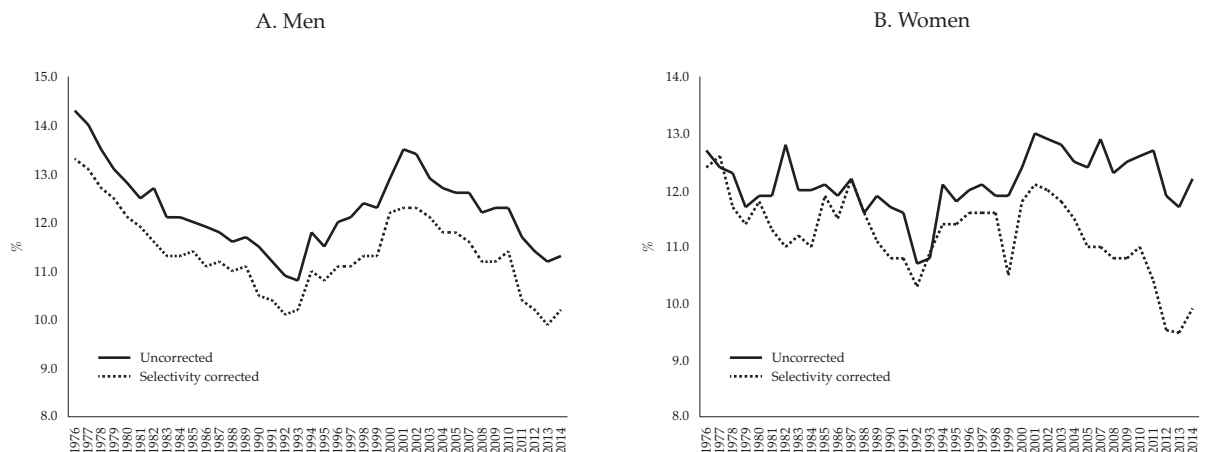
Table 5
MINCERIAN RETURNS TO EDUCATION

Source	Years	Without Selectivity Correction (%)			Unemployment Rates (%)		
		Total	Men	Women	Total	Men	Women
Household Surveys	1976	14.3	15.1	12.7	13.3	14.2	12.4
	1977	14.0	14.8	12.4	13.1	13.6	12.6
	1978	13.5	14.0	12.3	12.7	13.1	11.7
	1979	13.1	13.7	11.7	12.5	13.0	11.4
	1980	12.8	13.2	11.9	12.1	12.5	11.8
	1981	12.5	12.7	11.9	11.9	12.2	11.3
	1982	12.7	12.4	12.8	11.6	11.7	11.0
	1983	12.1	12.1	12.0	11.3	11.4	11.2
	1984	12.1	12.0	12.0	11.3	11.4	11.0
	1985	12.0	11.9	12.1	11.4	11.4	11.9
	1986	11.9	11.8	11.9	11.1	11.1	11.5
	1987	11.8	11.4	12.2	11.2	10.8	12.2
	1988	11.6	11.5	11.6	11.0	10.9	11.6
	1989	11.7	11.5	11.9	11.1	11.0	11.1
	1990	11.5	11.2	11.7	10.5	10.6	10.8
	1991	11.2	10.8	11.6	10.4	10.1	10.8
	1992	10.9	10.9	10.7	10.1	10.4	10.3
	1993	10.8	10.7	10.8	10.2	10.2	10.9
	1994	11.8	11.4	12.1	11.0	10.9	11.4
	1995	11.5	11.3	11.8	10.8	10.6	11.4
1996	12.0	12.0	12.0	11.1	11.2	11.6	
1997	12.1	12.0	12.1	11.1	11.2	11.6	
1998	12.4	12.7	11.9	11.3	11.9	11.6	
1999	12.3	12.4	11.9	11.3	11.7	10.5	
2000	12.9	13.2	12.4	12.2	12.7	11.8	
Continuous Household Surveys	2001	13.5	13.9	13.0	12.3	12.8	12.1
	2002	13.4	13.8	12.9	12.3	13.0	12.0
	2003	12.9	12.9	12.8	12.1	12.5	11.8
	2004	12.7	12.8	12.5	11.8	12.3	11.5
	2005	12.6	12.8	12.4	11.8	12.4	11.0
Integrated Household Surveys	2007	12.6	12.3	12.9	11.6	11.7	11.0
	2008	12.2	12.1	12.3	11.2	11.5	10.8
	2009	12.3	12.1	12.5	11.2	11.5	10.8
	2010	12.3	11.9	12.6	11.4	11.5	11.0
	2011	11.7	10.9	12.7	10.4	10.3	10.4
	2012	11.4	10.9	11.9	10.2	10.4	9.5
	2013	11.2	10.8	11.7	9.9	10.1	9.5
	2014	11.3	10.5	12.2	10.2	10.1	9.9

- In spite of the long period covered by the study (almost 40 years), the range of variation of the estimated returns is small (returns vary between 10.8% in 1993 and 14.3% in 1976). This shows a high level of stability during the period of study in spite of the increase in human capital and the important change in institutions and educational policy that took place during it.
 - It is possible to identify three periods in the evolution of returns: The first one, between 1976 and 1992, is one when the returns were decreasing. The second period (1992-2001) witnessed a recovery in returns, but never reached the level they had in 1976 (14.3%). Since then they started falling again. By 2014 their level is around 11%. The behavior of returns by gender is very similar, but the returns for women seem to have smoother fluctuations.
 - By gender (see Figures 6A and 6B) the behavior is similar to the one described. In the case of men the three sub-periods identified are very clearly observed. In the case of women there is more variance and the tendencies are less clear but in general are similar to those mentioned above.
 - It is not clear whether men's returns are larger or smaller than women's. The period of analysis starts with a large difference (over two percentage points) in favor of men, but by 1981 that difference had disappeared.
- After that, the evolution is very similar. Since 2005 the returns have been in favor of women, and the gap seems to be increasing. In 2014 the difference is 1.5 percentage points, the largest in favor of women in the whole period of analysis.

Figure 6

MINCERIAN RETURNST TO EDUCATION



1. Selectivity Correction

The fact that returns to education are estimated with samples of employed workers, could create some selectivity biases in the estimates. We started with the hypothesis that these biases were constant through time and therefore would not affect the tendencies in returns which is our main interest. However, the fact that the probability that a workers is employed could be affected by the evolution of unemployment could imply that this hypothesis is wrong. High or low unemployment periods could affect people with different levels of education differently and therefore affect the probability that a person is observed in the sample used to estimate returns, which implies that the bias is variable (and depends on unemployment). To correct for this possibility we apply a selectivity correction approach based on the estimation of probability of employment equations corrected by labor market participation, which was explained above. The results of that correction are presented in Table 5 and included in the figures already mentioned.

As expected, the selectivity-corrected returns estimates are smaller, although in general present the same behavior as the uncorrected returns. The differences (uncorrected versus corrected) fluctuate

between 0.6 and 1.8 percentage points. The gaps between corrected and uncorrected returns seem to be wider (and increasing) in the case of women, especially during the last 20 years of the period analyzed.

We also found that there is a small positive correlation between unemployment levels and the size of the bias in the returns to education, measured as the difference between uncorrected and corrected mincerian returns. The simple correlation coefficient was 0.04. This constitutes some evidence that unemployment affects the returns to education, but certainly more research is necessary on this point.

B. Spline Model

One way of checking whether the *average* returns to education generated by the Mincer equations are a good approximation for all levels of education is to use *spline* models. Here we use the *piecewise-linear-regression* model⁸ with one knot⁹ in the education variable. The obvious point to set the knot is at 11 years of education (complete pre-university education) because it allow us to obtain separate estimates of returns for pre-university and post-secondary education.¹⁰ The returns obtained are presented in Tables 6A and 6B, and summaries can be seen in Figures 7, 8A and 8B. The selectivity

⁸ See Pindyck and Rubinfeld,(1991), or Poirer (1978), or, more recently, Marsh and Cormier (2002)

⁹ In this case knots are the points in the regression line where slope changes.

¹⁰ Technical education is included in post-secondary education, but only in the last few years is possible to identify as a separate option from professional education.

Table 6
SPLINE RETURNS TO EDUCATION

Source	Year	Uncorrected		Selectivity Corrected		Mincerian Selectivity Corrected (%)
		Pre-University	Post-Secondary	Pre-University	Post-Secondary	
Household Surveys	1976	0.123	0.212	0.114	0.200	13.3
	1977	0.123	0.196	0.115	0.185	13.1
	1978	0.116	0.200	0.109	0.189	12.7
	1979	0.112	0.190	0.108	0.183	12.5
	1980	0.109	0.187	0.104	0.180	12.1
	1981	0.106	0.179	0.101	0.172	11.9
	1982	0.11	0.177	0.101	0.165	11.6
	1983	0.104	0.172	0.096	0.161	11.3
	1984	0.102	0.172	0.096	0.163	11.3
	1985	0.104	0.166	0.098	0.157	11.4
	1986	0.101	0.167	0.093	0.157	11.1
	1987	0.102	0.161	0.097	0.154	11.2
	1988	0.094	0.171	0.089	0.165	11.0
	1989	0.094	0.170	0.089	0.163	11.1
	1990	0.093	0.165	0.085	0.155	10.5
	1991	0.089	0.165	0.082	0.156	10.4
	1992	0.083	0.168	0.077	0.160	10.1
	1993	0.078	0.176	0.074	0.171	10.2
	1994	0.085	0.189	0.08	0.183	11.0
	1995	0.08	0.191	0.075	0.184	10.8
1996	0.084	0.199	0.076	0.190	11.1	
1997	0.088	0.187	0.08	0.177	11.1	
1998	0.083	0.200	0.074	0.189	11.3	
1999	0.082	0.200	0.075	0.191	11.3	
2000	0.091	0.194	0.087	0.187	12.2	
Continuous Household Surveys	2001	0.09	0.208	0.081	0.196	12.3
	2002	0.09	0.205	0.081	0.193	12.3
	2003	0.083	0.200	0.078	0.191	12.1
	2004	0.078	0.199	0.072	0.190	11.8
	2005	0.078	0.193	0.073	0.185	11.8
Integrated Household Surveys	2007	0.075	0.188	0.07	0.178	11.6
	2008	0.064	0.195	0.058	0.184	11.2
	2009	0.063	0.200	0.056	0.189	11.2
	2010	0.061	0.201	0.063	0.203	11.4
	2011	0.054	0.192	0.055	0.193	10.4
	2012	0.052	0.188	0.052	0.187	10.2
	2013	0.045	0.188	0.045	0.187	9.9
	2014	0.043	0.188	0.042	0.186	10.2

Table 6A
SPLINE RETURNS FOR MEN

Source	Year	Uncorrected		Selectivity Corrected		Mincerian Selectivity Corrected (%)
		Pre-University	Post-Secondary	Pre-University	Post-Secondary	
Household Surveys	1976	0.13	0.211	0.122	0.201	14.2
	1977	0.129	0.197	0.119	0.183	13.6
	1978	0.119	0.197	0.112	0.185	13.1
	1979	0.119	0.185	0.113	0.177	13.0
	1980	0.111	0.191	0.105	0.182	12.5
	1981	0.105	0.186	0.098	0.178	12.2
	1982	0.105	0.179	0.098	0.17	11.7
	1983	0.098	0.180	0.091	0.171	11.4
	1984	0.098	0.174	0.093	0.167	11.4
	1985	0.099	0.170	0.095	0.164	11.4
	1986	0.095	0.170	0.089	0.164	11.1
	1987	0.094	0.165	0.089	0.159	10.8
	1988	0.088	0.181	0.083	0.175	10.9
	1989	0.086	0.181	0.08	0.175	11.0
	1990	0.087	0.169	0.081	0.161	10.6
	1991	0.081	0.172	0.073	0.164	10.1
	1992	0.081	0.173	0.076	0.167	10.4
	1993	0.075	0.182	0.069	0.177	10.2
	1994	0.079	0.195	0.073	0.19	10.9
	1995	0.075	0.196	0.069	0.189	10.6
1996	0.082	0.202	0.074	0.195	11.2	
1997	0.084	0.194	0.076	0.186	11.2	
1998	0.085	0.206	0.082	0.197	11.9	
1999	0.085	0.202	0.078	0.195	11.7	
2000	0.096	0.196	0.092	0.19	12.7	
Continuous Household Surveys	2001	0.097	0.205	0.087	0.195	0.128
	2002	0.098	0.201	0.091	0.193	0.13
	2003	0.088	0.195	0.085	0.19	0.125
	2004	0.082	0.198	0.078	0.193	0.123
	2005	0.083	0.191	0.08	0.186	0.124
Integrated Household Surveys	2007	0.078	0.183	0.074	0.176	0.117
	2008	0.069	0.188	0.065	0.181	0.115
	2009	0.066	0.194	0.062	0.189	0.115
	2010	0.063	0.192	0.063	0.19	0.115
	2011	0.052	0.18	0.051	0.177	0.103
	2012	0.053	0.179	0.052	0.175	0.104
	2013	0.047	0.178	0.046	0.175	0.101
	2014	0.048	0.173	0.046	0.169	0.101

Table 6B
SPLINE RETURNS FOR WOMEN

Source	Year	Uncorrected		Selectivity Corrected		Mincerian Selectivity Corrected (%)
		Pre-University	Post-Secondary	Pre-University	Post-Secondary	
Household Surveys	1976	0.113	0.209	0.11	0.204	12.4%
	1977	0.113	0.182	0.117	0.188	12.6%
	1978	0.107	0.203	0.104	0.198	11.7%
	1979	0.101	0.195	0.101	0.195	11.4%
	1980	0.105	0.178	0.109	0.183	11.8%
	1981	0.106	0.166	0.102	0.16	11.3%
	1982	0.115	0.175	0.101	0.157	11.0%
	1983	0.109	0.155	0.104	0.148	11.2%
	1984	0.105	0.168	0.098	0.158	11.0%
	1985	0.109	0.159	0.108	0.158	11.9%
	1986	0.106	0.159	0.103	0.155	11.5%
	1987	0.111	0.155	0.114	0.158	12.2%
	1988	0.102	0.157	0.104	0.159	11.6%
	1989	0.105	0.154	0.099	0.146	11.1%
	1990	0.1	0.159	0.093	0.15	10.8%
	1991	0.1	0.156	0.095	0.149	10.8%
	1992	0.083	0.159	0.083	0.159	10.3%
	1993	0.082	0.168	0.087	0.174	10.9%
	1994	0.092	0.180	0.091	0.178	11.4%
	1995	0.086	0.185	0.087	0.186	11.4%
1996	0.085	0.193	0.086	0.194	11.6%	
1997	0.092	0.178	0.091	0.176	11.6%	
1998	0.078	0.191	0.082	0.197	11.6%	
1999	0.077	0.197	0.07	0.188	10.5%	
2000	0.083	0.191	0.082	0.19	11.8%	
Continuous Household Surveys	2001	0.08	0.208	0.08	0.208	0.121
	2002	0.079	0.208	0.078	0.206	0.12
	2003	0.077	0.205	0.074	0.2	0.118
	2004	0.072	0.198	0.071	0.197	0.115
	2005	0.07	0.194	0.069	0.192	0.11
Integrated Household Surveys	2007	0.073	0.194	0.066	0.182	0.11
	2008	0.057	0.202	0.055	0.198	0.108
	2009	0.057	0.204	0.053	0.198	0.108
	2010	0.057	0.208	0.061	0.213	0.11
	2011	0.056	0.202	0.059	0.207	0.104
	2012	0.05	0.196	0.052	0.199	0.0952
	2013	0.043	0.197	0.045	0.199	0.0948
	2014	0.038	0.204	0.037	0.202	0.0991

corrected mincerian returns are included both in the tables and in the figures below as a reference point for the analysis. As in the case of the mincerian model, all the returns and the post-secondary

premiums estimated with the spline model had high levels of statistical significance (above 1%).

Some of the most important conclusions are the following:

- The first and most striking conclusion is that there is a very clear difference in the levels, and the behavior of the returns to education by education levels.
- The returns to pre-university education show approximately the same patterns as the average (mincerian) returns, but the recovery after 1992 was much weaker and ended two years earlier than that of the average returns. After that moment these returns dropped rapidly (almost 5 percentage points between 2000 and 2014).

Figure 7

SPLINE RETURNS TO EDUCATION

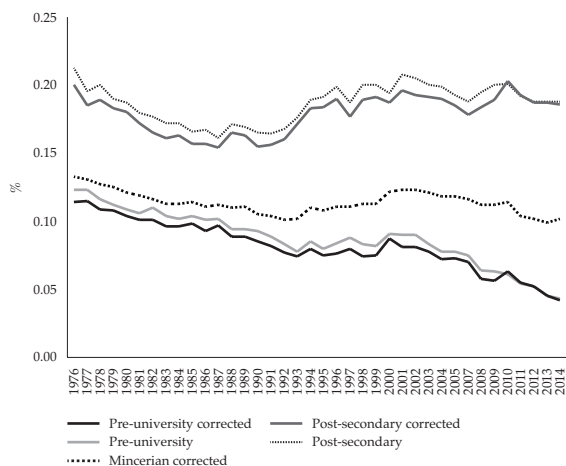
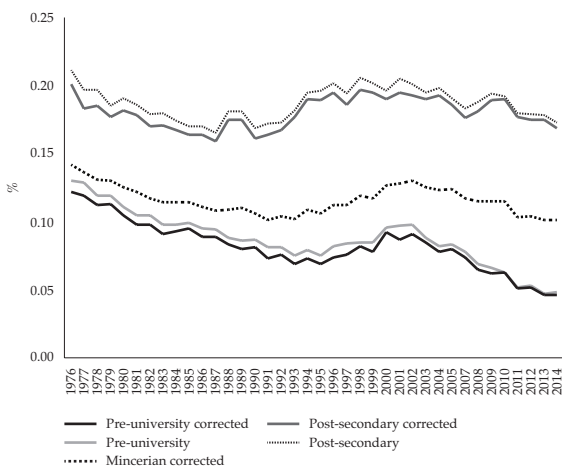


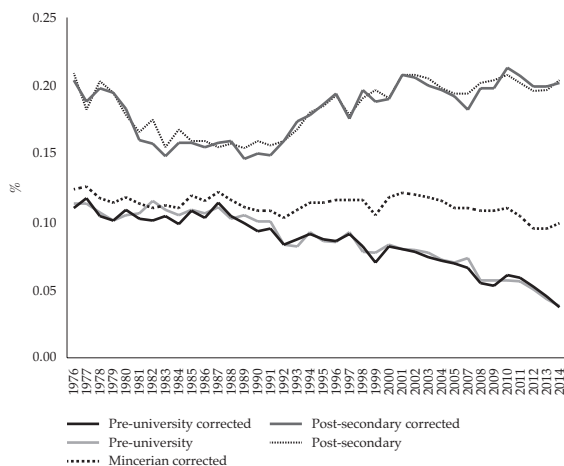
Figure 8

MINCIERIAN RETURNST TO EDUCATION

A. Men



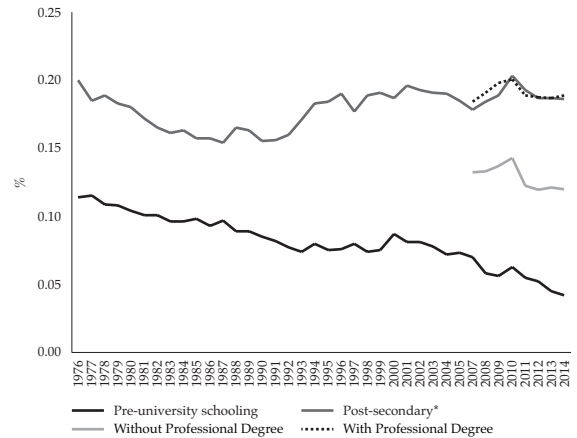
B. Women



- On the other hand, the returns to post-secondary education dropped between 1976 and 1986, increased rapidly between that year and 1996, and stabilized around 20% since then.
- The explanation why the average returns (mincerian) have decreased since 2002 is the fast decline in the pre-university ones. The gap between pre-university and post-secondary education has been widening since around 1986, but particularly in the 21st century.
- The behavior for men and women is similar to the one described above, except that in the case of women the returns to pre-university education have been declining during the whole period of analysis and the gap between returns to pre-university and post-secondary is much wider than in the case of men and has been growing much faster.

With the information available after 2007 it is possible to distinguish between persons who took post-secondary education and obtained a professional degree and those who did not. So, for these years, we estimated a version of the spline model that allow us to estimate the difference in returns between having and not having a degree such as the one in equation (4A). The results are presented in Table 6C and summarized in Figure 9.

Figure 9
SPLINE RETURNS TO EDUCATION WITH AND WITHOUT PROFESSIONAL DEGREE



* Only since 2008 it is possible to differentiate people with and without post-secondary degreee/

Our results indicate that there is a large difference in educational returns between having and not having a degree and that the difference appears to be growing fast, in 2007 there was a 5 percentage-points difference and by 2014 it had grown to almost 7 points. This indicated that formal credentialism is an important element of Colombian labor markets in the sense that academic degrees are a criterion to set wages.¹¹

C. Quantile Regression Model

As indicated above, Quintile Regression models is a technique that allows us to estimate returns to

¹¹ This is consistent with findings in, Alvarez and Jiménez (2015) indicating that professional or technical degrees are important to explain unemployment: people with degrees have lower probability of being unemployed, and if they are unemployed, have shorter search periods.

Table 6C
SPLINE RETURNS WITH AND WITHOUT PROFESSIONAL DEGREE*

Source	Year	Pre-University Schooling (%)	Post-Secondary		
			Post Secondary** (%)	Without Professional Degree (%)	With Professional Degree (%)
Household Surveys	1976	11.40	20.00		
	1977	11.50	18.50		
	1978	10.90	18.90		
	1979	10.80	18.30		
	1980	10.40	18.00		
	1981	10.10	17.20		
	1982	10.10	16.50		
	1983	9.60	16.10		
	1984	9.60	16.30		
	1985	9.80	15.70		
	1986	9.30	15.70		
	1987	9.70	15.40		
	1988	8.90	16.50		
	1989	8.90	16.30		
	1990	8.50	15.50		
	1991	8.20	15.60		
	1992	7.70	16.00		
	1993	7.40	17.10		
	1994	8.00	18.30		
	1995	7.50	18.40		
1996	7.60	19.00			
1997	8.00	17.70			
1998	7.40	18.90			
1999	7.50	19.10			
2000	8.70	18.70			
Continuous Household Surveys	2001	8.10	19.60		
	2002	8.10	19.30		
	2003	7.80	19.10		
	2004	7.20	19.00		
	2005	7.30	18.50		
Integrated Household Surveys	2007	7.00	17.80	13.23	18.41
	2008	5.80	18.40	13.33	19.10
	2009	5.60	18.90	13.71	19.80
	2010	6.30	20.30	14.26	20.05
	2011	5.50	19.30	12.24	18.91
	2012	5.20	18.70	11.95	18.72
	2013	4.50	18.70	12.14	18.69
	2014	4.20	18.60	11.96	18.87

* Corrected for selectivity bias.

** Corresponds to the returns of the spline regression in Table 6A.

education for different segments of the distribution of labor hourly income (our dependent variable). In the exercise we used several percentiles, but we present only the results for quartiles (q25, q50, and q75) in Table 7. Figure 10 summarizes such results.

Some of the most important conclusions are the following:

- In general the quintile returns are higher for the upper part of the distribution of labor hourly income than for the bottom part. Since 2001 the gap between the top quartile (q75) and the lowest one (q25) has widened a great deal (from 1.2 percentage points to 2.5). The largest gap was in 1994 (3 percentage points). The gaps in returns between the first and the second quartile (q25 and q50) are small and some time the returns are higher for q25.
- The evolution of quintile returns to education for men is similar to the total, but women's returns behave very differently. For one thing, the volatility of the returns for women is much higher than that of men, which makes it difficult to identify a clear path of behavior. Also, the difference between the upper and lower quintiles is much narrower in the case of women. It seems like the gap between the third and the first quartile has been widening since 2001, both for men and for women.
- In general the returns for women are higher than those for men in the lower percentiles of the distribution of labor hourly earnings, but as one moves to higher percentiles the situation changes. In the third quartile the returns are higher for men in almost all the years of the period studied.

Figure 10

QUANTILIC RETURNS TO EDUCATION



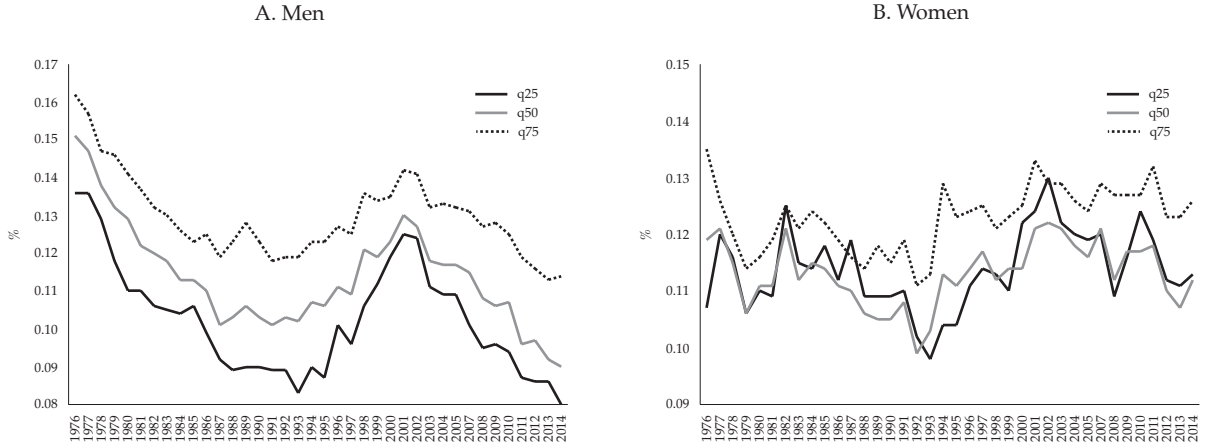
VII. Summary and Conclusions

The exercise we just presented is an attempt to understand the evolution of returns to education in the last 40 years. It is based in estimates made using the most similar data possible, but the various changes (improvements) in methodologies that occur through times impose limitations to the analysis. In spite of that, it was possible to construct consistent series of returns to education based on different techniques of estimation, that present a fairly coherent picture of what happened in recent years.

Table 7
QUANTILIC RETURNS TO EDUCATION

Source	Year	Men			Women			Total		
		q25	q50	q75	q25	q50	q75	q25	q50	q75
Household Surveys	1976	0.136	0.151	0.162	0.107	0.119	0.135	0.128	0.14	0.151
	1977	0.136	0.147	0.157	0.12	0.121	0.126	0.13	0.139	0.145
	1978	0.129	0.138	0.147	0.116	0.115	0.12	0.126	0.131	0.138
	1979	0.118	0.132	0.146	0.106	0.106	0.114	0.116	0.123	0.135
	1980	0.11	0.129	0.141	0.11	0.111	0.116	0.112	0.122	0.132
	1981	0.11	0.122	0.137	0.109	0.111	0.119	0.111	0.119	0.13
	1982	0.106	0.12	0.132	0.125	0.121	0.125	0.114	0.121	0.13
	1983	0.105	0.118	0.13	0.115	0.112	0.121	0.11	0.116	0.127
	1984	0.104	0.113	0.126	0.114	0.115	0.124	0.109	0.115	0.125
	1985	0.106	0.113	0.123	0.118	0.114	0.122	0.112	0.113	0.123
	1986	0.099	0.11	0.125	0.112	0.111	0.119	0.106	0.11	0.123
	1987	0.092	0.101	0.119	0.119	0.11	0.116	0.104	0.105	0.118
	1988	0.089	0.103	0.123	0.109	0.106	0.114	0.099	0.105	0.12
	1989	0.09	0.106	0.128	0.109	0.105	0.118	0.098	0.106	0.124
	1990	0.09	0.103	0.123	0.109	0.105	0.115	0.099	0.105	0.121
	1991	0.089	0.101	0.118	0.11	0.108	0.119	0.099	0.105	0.119
	1992	0.089	0.103	0.119	0.102	0.099	0.111	0.096	0.102	0.116
	1993	0.083	0.102	0.119	0.098	0.103	0.113	0.09	0.103	0.116
	1994	0.09	0.107	0.123	0.104	0.113	0.129	0.095	0.11	0.126
	1995	0.087	0.106	0.123	0.104	0.111	0.123	0.094	0.109	0.123
1996	0.101	0.111	0.127	0.111	0.114	0.124	0.106	0.113	0.126	
1997	0.096	0.109	0.125	0.114	0.117	0.125	0.104	0.113	0.125	
1998	0.106	0.121	0.136	0.113	0.112	0.121	0.11	0.118	0.13	
1999	0.112	0.119	0.134	0.11	0.114	0.123	0.112	0.117	0.13	
2000	0.119	0.123	0.135	0.122	0.114	0.125	0.121	0.119	0.131	
Continuous Household Surveys	2001	0.125	0.13	0.142	0.124	0.121	0.133	0.126	0.127	0.138
	2002	0.124	0.127	0.141	0.13	0.122	0.129	0.127	0.124	0.136
	2003	0.111	0.118	0.132	0.122	0.121	0.129	0.117	0.12	0.131
	2004	0.109	0.117	0.133	0.12	0.118	0.126	0.114	0.118	0.129
	2005	0.109	0.117	0.132	0.119	0.116	0.124	0.114	0.116	0.128
Integrated Household Surveys	2007	0.101	0.115	0.131	0.12	0.121	0.129	0.11	0.117	0.13
	2008	0.095	0.108	0.127	0.109	0.112	0.127	0.102	0.11	0.127
	2009	0.096	0.106	0.128	0.116	0.117	0.127	0.105	0.111	0.128
	2010	0.094	0.107	0.125	0.124	0.117	0.127	0.107	0.111	0.126
	2011	0.087	0.096	0.119	0.119	0.118	0.132	0.102	0.105	0.124
	2012	0.086	0.097	0.116	0.112	0.11	0.123	0.099	0.102	0.12
	2013	0.086	0.092	0.113	0.111	0.107	0.123	0.097	0.099	0.117
	2014	0.08	0.09	0.114	0.113	0.112	0.126	0.094	0.099	0.12

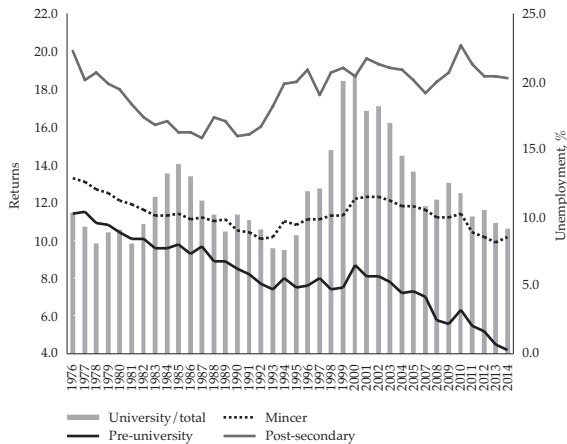
Figure 11
QUANTILIC RETURNS TO EDUCATION



The best summary of our estimates is presented in Figure 12, below. In this figure we have the selectivity corrected returns of the micerian and spline models, as well as the rates of unemployment for the whole period.

The general conclusion is that the mincerian returns to education have been declining since the beginning of the century, but this decline seems to be caused by the drop in the returns to pre-university education (11 years of education or less). The returns to post-secondary education have been increasing (with ups and downs) since the early 1990 's, in spite of the fact that the unemployment rates for this sector of the population seem to have increased relatively to the rates of other groups. In our estimates we also found evidence (not presented here) that an important part of the returns to post-secondary education is associated to some formal credentialism in the sense that university degrees have a premium relative to the same levels of education without a degree.

Figure 12
COMPARISON OF RETURNS TO EDUCATION ESTIMATES



Although the purpose of this paper is to describe the evolution of educational returns rather

than explain it, it is tempting to present some hypothesis that could help to understand it. The drop in returns between 1976 and 1992 probably was the result of the increase in the supply of human capital produced by the expansion of educational services by the government in previous years. By the late 80s the country started a revision of its growth strategy, switching from an import substitution one to a more open economy approach. This generated a change in the composition of the

demand for labor in favor of the skilled workers, which resulted in an increase in their relative earnings (vis-a-vis unskilled ones) and in their returns to education. The recession of the end of the century, the worst in the recent history of the country, brought the labor market back to the path of decreasing returns to education for workers with pre-university education, probably as a result of the increase in the relative supply of this group of persons vis a vis their demand.

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