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Abstract

We provide evidence of private returns to education and of externalities which jointly render social returns to education in Colombia. The spillover is generated by the share of college-educated workers within the working-age population. Thus, the higher this share in the cities, the higher the wages. The size of the externality is about 1.13; that is, an increase of one percentage point in the share will increase wages by 1.13%. For mid-to-high and high educated workers the externality is about 1.07 and 1.3 while for low educated workers it is 0.92,. The public policy program instituted by the agency in charge of promoting undergraduate and graduate education has contributed to increase wages all over the country but mainly in cities different from Bogotá. A positive correlation between the size of cities and human capital agglomeration is also observed; as a result, the size of cities also has predictive power on the externality.

Key words: human capital agglomeration, social returns, private returns, externalities.
JEL Classification: *J*2, *J*3.

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1. Introduction

Heterogeneity of the labor market outcomes across cities or provinces within countries is a very-well known fact all over the world (see Elhorst, 2003), and Colombia is not an exception. This country reports sizeable geographic differences in unemployment, occupation, participation rates, and wages among many other outcomes (see Gamarra, 2005; Galvis, 2010; Arango, 2013; and, Cárdenas, Hernández and Torres, 2014). This paper addresses the heterogeneity of wages and returns to education across regions in Colombia by using human capital agglomeration as the major argument.

Investment in human capital is undertaken, among other things, to generate returns. However, this, as is the case for many other investments, generates both social and private returns. The latter are the internal rate of return at which the present discount values of the direct plus the indirect costs of schooling and the present discount value of the after-tax labor income are equal. In order to determine social returns, it is necessary to take into account that, apart from the private costs, there are public and private subsidies that the human capital investor does not bear. Besides private earnings, there are also taxes and some net positive externalities that are not captured by the investor (Schultz, 1988).

Human capital theory has been extensively tested by means of the Mincerian equations in which the coefficients of education are directly related to the internal rate of return. However, estimating social gains entails some difficulties (Becker, 1964, p. 208). One of the aspects that makes it hard to estimate social gains is that of externalities[1] or spillovers generated by aggregate human capital that yield social returns higher than the rate of return.[2] Given the interactions between people and processes,[3] education has potential effects not only on the wages of people who have acquired human capital,[4] but also on the wages of all workers. More precisely, we follow

[1] Following Schultz (1988), "education is widely viewed as a public good (with positive externalities) which increases the efficiency of economic and political institutions while hastening the pace of scientific advance."

[2] Schultz (1988, page 585) said: "… if taxes are proportional to wages, the distinction between private and social returns is, in practice, the inclusion of the social cost of public expenditures per pupil in addition to family costs of schooling. Social returns are, therefore, always lower than private returns to the extent that the educational system is publicly subsidized."

[3] For Rauch (1993), interactions can be both formal and informal. They are characterized as the sharing of knowledge and skills between workers.

[4] However, education has effects not only on wages, as evidence of productivity gains, but also on a number of dimensions of society (Moretti, 2004b). When a city is populated by persons of high education level, there is a lower crime rate (Lochner and Moretti, 2003), higher civic culture (Dee, 2004), better decisions about politicians and government (e.g., less political corruption; Gleaser and Saks, 2006), reduction of teenage pregnancy, and so on. Over

Moretti (2004a) and Acemoglu and Angrist (2000) in defining external returns to education - net of the private returns- as the effect on individual's wages in a city owed to an increase in the share of educated workers.[5]

There are at least four reasons why social returns could be different from private returns. First, technological externalities which take place when, for example, workers of the same industry interact and learn different methods and processes to increase productivity from each other (Lucas, 1988; Moretti, 2004a). Second, pecuniary externalities that arise due to complementarities between human and physical capital (see also Acemoglu, 1996; Moretti, 2004a). In this case, the optimal stock of physical capital depends on the level of education of the labor force. If the latter increases its human capital, a higher stock of physical capital will be used for all workers.[6] A third type of externality might appear when the consumption and demand mechanism is considered (see Manning, 2004; Mazzolari and Ragusa, 2007). According to this mechanism, there is a higher demand for low skilled workers to attend the production of services and leisure activities required by the skilled ones.[7] A fourth type of externality, negative in essence, occurs when private returns are higher than social ones. This is the case when the labor market is not big enough and does not have a sufficient number of jobs available for workers both with a high stock of human capital and, likewise, intrinsic desired qualities and people with less abilities and human capital. As a result, the former workers would fill the available jobs leaving the latter without the possibility of being posted.

Apart from the spillover effects, the literature also recognizes the effect of imperfect substitution between highly skilled and less skilled workers which could add to the size of the externality. In this case, an increase of the college educated share could raise, firstly, the wages of high educated workers who would be substituted by less educated workers for whom the wages

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the years, higher education has been deemed to influence society differently from other kinds of education. For instance, an important share of generation of knowledge is developed in the environment of the higher education; at the same time, some technological shifts which clearly impact the productivity of firms are advanced in the realm of higher education. Another important reason is that higher education boosts diversity of skills, and consequently interactions among workers which potentially increase productivity (see Bettencourt, Samaniego, and Youn, 2014). Assuming that all these arguments are true, cities inhabited by people with higher education should have higher wages.

[5] Qualifications to this interpretation of the parameter linked to schooling or education can be found in Carneiro et al. (2013). However, in this article we follow the interpretation used in this literature (see, for example, Acemoglu and Angrist, 2000; Moretti, 2004a).

[6] This assertion depends heavily on the characteristics of the matching in the labor market. If the matching process is random, this result holds.

[7] Díaz (2013) analyses this particular externality in the case of employment creation in Colombia.

would also increase. For higher educated workers, the effect of the increases in the supply of more educated workers would also reduce their wages (Moretti, 2004a). Evidence of externalities has been provided by Moretti (2004a) and Rauch (1993), among many others. In contrast, Acemoglu and Angrist (2000) found an effect not statistically different from zero. More recently, Sand (2013) found important positive spillovers during the eighties but not during the nineties, while Bratti and Leombruni (2014) found only a small effect for white-collar workers, and no positive effect for the blue-collar supply of more educated workers.

This article aims to test the hypothesis that wages in Colombia contain external returns and that these are responsive to the human capital sited in each city. We explore another dimension of the labor market heterogeneity by testing whether wages in Colombia are higher in cities populated by more educated workers due to the externalities or imperfect substitution, in the case of less educated workers. This is carried out by means of Mincer-type equations in which the educated labor force is measured by the share of college educated people in the working-age population. To the best of our knowledge, this is the first time that this topic is examined in this country, despite the disparities that characterize the labor market outcomes among cities in Colombia. In addition, given the different levels of educational composition of the labor force, it is important to know whether the results found for countries such as the United States, hold for Colombia.

The fact that, presumably, individuals and firms are not randomly distributed among the cities would prevent us from making a consistent estimation of the externality. A first potential source of problems for the estimation of the size of the externality is that workers with higher unobserved ability –rather than higher productivity- could decide to live in cities where the share of well-educated workers is also high. Under these circumstances, endogeneity emerges because the unobserved ability is correlated not only with wages, but also with the share of a well-educated workforce.[8] Regarding this argument, Acosta, Muller and Sarzosa (2015), based on the Skills toward Employment and Productivity (STEP) Household Survey,[9] have recently shown that socio-emotional skills do not have an important effect on earnings; rather, they affect labor participation and schooling decisions in Colombia.[10] Accordingly, these findings suggest that the Big-Five

[8] Of course, diversity of skills is a very important dimension of workforce education.
[9] The socio-emotional skills are comprised by the Big-Five personality traits. They are: openness, conscientiousness, extraversion, agreeableness, and emotional stability.
[10] Viinikainen and Kokko (2012) show the relationship between openness and unemployment at the prime-age working.

personality traits, an expression of some kind of unobserved ability (socio-emotional skills) of individuals, might lead to inconsistent parameters if we consider that they can potentially affect the share of college educated workers.[11] Moreover, there are dimensions of the unobserved ability other than those related to the Big-Five traits that could still be related to the college-educated proportion of workers and, thus, might be another source of parameter inconsistency.[12]

Reverse causality might also emerge as a potential problem. This could be the case when, for example, higher wages attract higher educated workers irrespective of their unobserved ability. To provide some intuition for this situation, imagine the case in which the productive structure of cities also determines wages. In this circumstance, cities where productivity is higher could pay higher wages and attract more college-educated workers with respect to the labor force.[13] To face these two potential problems, an instrumental variable approach is implemented. This is adopted to obtain consistent estimates of the parameter of interest by using the information from household surveys between 2007 and 2012. Our results suggest that the size of the externality is 1.13, which means that an increase of one percentage point in the share of college educated people in the working-age population would increase wages by 1.13%.

The article also discusses, in this context, the role played by the Colombian Institute for Educational Credit and Technical Studies Abroad (Instituto Colombiano de Crédito Educativo, hereinafter *Icetex*). This is a public institution oriented to promote higher education by means of credits and scholarships to undergraduate and graduate students. Thus, we ask whether the externality is, if at all, reinforced or weakened by the interventions of Icetex. When the share in the number of loans granted by Icetex is taken into account the size of the externality is 0.716 while the coefficient of this share is 0.39.

Finally, given the regional disparities of the Colombian labor market, one question that arises from this analysis is: What are the determinants of the human capital agglomeration? The answer

[11] Some caution is recommended with the argument of Acosta, Muller and Sarzosa (2015) since labor force participation –the extensive margin of labor supply- is, in a general equilibrium perspective, highly related to wages.
[12] This is the case of achievement orientation, interpersonal relationships, ethical and moral values, and emotional resources, which, for measurement purposes, are intended to be captured by other psychological devices such as the Wartegg test.
[13] This source of inconsistency is related with the migration of the labor force within the country. Evidence of labor mobility in Colombia has been provided by Galvis (2002) and Espinosa (2003). Guataquí and Roa (2010), show that workers of higher educational attainments also have higher mobility (see also Roa, 2008). More recently, Barón (2013) presented evidence that does not support the hypothesis of a high migration in Colombia (see also Bernal, 2013).

to this question should consider the public and private supply of education, the local productive vocation, the role of some other social networks and organizations in charge of promoting human capital formation, the local amenities, and, any feedback from wages to human capital decisions, among many other elements. The evidence we provide below suggests that the size of the spillover remains when the share of college-educated workers in a city is substituted for the population of the city as a proportion of total population of the country (see Wheeler, 2006).

The rest of the paper is organized as follows. The second section provides some partial equilibrium insights on the link between wages and human capital agglomeration from the labor demand point of view. Section three describes the data and presents the empirical approach. It also provides an explanation of the difficulties entailed by the non-random distribution of individuals around the country together with the results. Section four discusses the results when Bogotá, the capital city, is excluded from the sample, as well as the role played by the *Icetex*, and the relevance of the size of cities when this variable is used instead of the share of well-educated workers. Finally, section five draws some conclusions.

2. Human capital agglomeration and wages

Studies of the topic at hand for the case of Colombia include González, Guzmán and Pachón (1998) which found that social returns of education increased between 1975 and 1996 by using quarterly information of household surveys. The authors, based on Acemoglu (1996), claimed that the returns were pecuniary in essence, and that some groups of less skilled workers benefit from external returns and from the higher human capital of the economy. Interestingly, this investigation, focused on aggregate data for seven cities, found that the greater the educational attainments the higher the social returns and the lower the private ones.

Later, Castellar and Uribe (2001) found that in Cali, the third largest city of Colombia, the income premium depended on the concentration of human capital within the same group of the individual.[14] According to them, the concentration of human capital in different groups generates an income premium for those belonging to each group; this fact explains the higher social return. More recently, in a related work Díaz (2013) shows that human capital agglomeration benefits the rate of occupation of higher educated workers. She also provides evidence that these workers affect

[14] According to Castellar and Uribe (2001), an implication of their results is a change in economic policies aimed at translating resources from professional education in public institutions to primary education.

the employment of other workers in local labor markets.[15] According to her, these results are explained by externalities of human capital complementarity in the production and consumption spillovers.

The empirical approach of this article rests on an income equation. Nevertheless, the road for arriving at this equation corresponds to a partial equilibrium approach in which a firm chooses high and low educated workers with the purpose of maximizing benefits. Moretti's (2004a) approach, which we follow closely, is competitive in principle.[16] It assumes that output is produced by employing workers of high (N_h) and low (N_l) education, $N = N_h + N_l$, as well as physical capital (K) under a Cobb-Douglas technology. That is:

$$y = (\varphi_h N_h)^{\alpha_h}(\varphi_l N_l)^{\alpha_l} K^{1-\alpha_h-\alpha_l} \qquad (1)$$

A crucial assumption of this approach is that a worker's productivity depends on the share of well-educated workers in the city, $n = N_h/N_h + N_l, n < 1$. Thus, we have:

$$log(\varphi_j) = \phi_j + \gamma_j n \qquad j = h, l$$

where φ_j $(\varphi_h > \varphi_l)$ represents the effect of human capital on the productivity of each specific group. With these assumptions about productivity, in the absence of spillovers ($\gamma_j = 0$), the empirical approach collapses to a standard Mincer-type income equation, while in the case of positive spillovers $\gamma_j > 0$, other variables related to human capital in the city should be considered.

Given the production function in equation (1), if wages are equal to marginal product of labor, it can be shown that when the proportion of high educated workers increases, the *ex-ante* effects on wages are given by (see Moretti, 2004a):

$$\frac{d\, log(w_h)}{dn} = \frac{(\alpha_h - 1)}{n} - \frac{\alpha_l}{(1-n)} + (\alpha_l\gamma_l + \alpha_h\gamma_h) \qquad (2)$$

$$\frac{d\, log(w_l)}{dn} = \frac{(1-\alpha_l)}{(1-n)} + \frac{\alpha_h}{n} + (\alpha_l\gamma_l + \alpha_h\gamma_h) \qquad (3)$$

[15] The empirical approach of Díaz (2013) is similar to ours; however, she focused in employment effects instead of on wages by using census data and different municipalities.

[16] Acemoglu and Angrist (2000) employ a theoretical framework where the labor market is not competitive; instead, workers and firms are matched randomly. The former have schooling and some unobserved ability. The equilibrium in this economy consists of a set of schooling choices and capital investment. This set up allows them to arrive to a wage equation in which an explanatory variable is the average schooling in each state. They estimate that private returns are about seven percent, while external returns are small, not significantly different from zero.

According to these expressions, the spillover of human capital that increases productivity is represented by $(\alpha_l\gamma_l + \alpha_h\gamma_h)$. In equation (2), the other elements are negative as a prediction that wages of highly educated workers decrease when their proportion in the labor force rises. Conversely, in equation (3), the sum of the first two elements is positive, showing the effect of imperfect substitution between high and low educated workers. Given our assumptions, $d\,log(w_h)/dn < d\,log(w_l)/dn$ is expected.[17]

3. Data, empirical approach and results

To test whether local human capital agglomeration affect wages in Colombia, we use the information about salaried workers (both private and public) from the household surveys (GEIH)[18] carried out between July 2008 and June 2012. The wages correspond to hourly earnings. We define college educated individuals as persons with at least fifteen years of education. To preview whether the hypothesis of externalities of human capital has any possibility in the Colombian labor market, Figure 1 shows the correlation between regression-adjusted average wages and the percentage of college graduates in the thirteen cities, normally used to represent the urban situation of the labor market in Colombia (see the list of cities in Table 1).

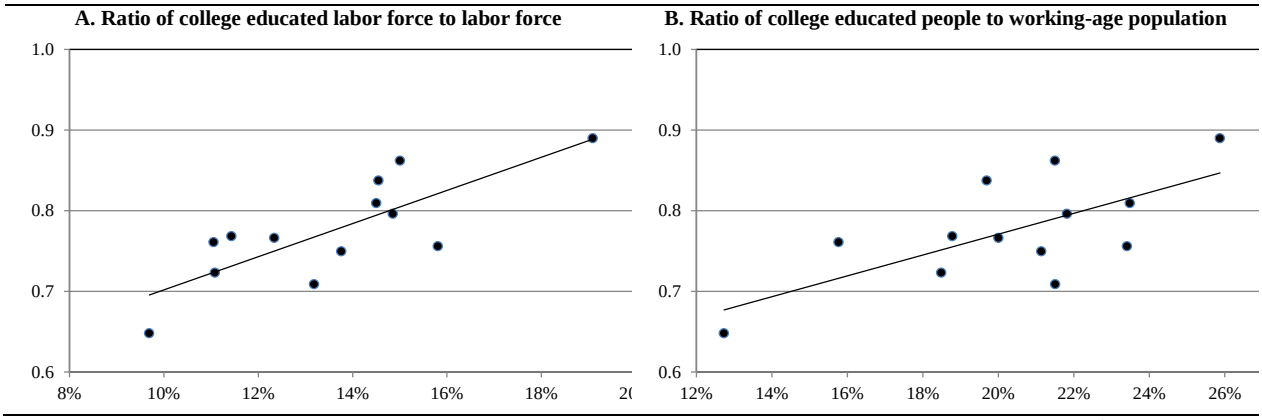
In panel A, human capital agglomeration is measured by the share of college educated people in the labor force from the household surveys (GEIH) between 2008 and 2012, while in panel B it

[17] The relationship among wages, rent of houses and amenities within cities has also nourished the literature on wage differentials across cities as well as on the disparities in productivity and labor market outcomes. For example, according to Roback (1982), workers would demand wages that would compensate living in an unpleasant city (due to pollution, weather conditions, crime, and so on), while firms located there would need a higher productivity in order to pay higher wages. In this model, the worker's problem is to optimally select the quantities of the commodity and the residential land given the amount of amenities in the city. Given the level of utility reached by each worker, the indifference curve is upward sloped in the space wages-housing rent. Thus, to be indifferent among the cities with different levels of amenities, workers in every wage level have to pay higher rents. The model also assumes that firms minimize costs subject to a production technology. Thus, the equilibrium solution reports wages and rents as functions of amenities, given the level of indirect utility (equal in all occupied locations). Rauch (1993) shows that cities with higher levels of human capital (regarded as a public good) should have higher wages and rents. This argument is supported by the external effects generated by human capital on total factor productivity. According to Rauch, the problem with the hypothesis that human capital externalities cause wage differentials is that the former is related to a large stock of physical capital per capita technologically updated. Migration within the country leads high-wages areas to high-rent land. This way, utility levels and production costs are equalized across cities. A related question is addressed by Wheeler (2006) who obtains results showing that human capital growth is correlated to population size and the existing stock of college-educated labor. That is, cities with larger populations and workers with higher education (bachelor degree) exhibit higher growth rates of human capital than cities with less population and workers with higher education. This empirical evidence is obtained by using a sample of more than 200 U.S. metropolitan areas.

[18] Gran Encuesta Integrada Hogares of Departamento Administrativo Nacional de Estadística, DANE (Colombia's Bureau of Official Statistics).

is measured as the share of college educated people in the working-age population according to the 2005 population census. Each dot in panel A corresponds to the mean of regression-adjusted average wage during the period 2008:06-2012:06 of each city in the domain of the thirteen urban areas and the mean of the share of college-educated workers based on the GEIH (2008:06-2012:06), or the mean of the share of college-educated people based on the 2005 census. In both cases the relation is positive, which suggests that the higher the agglomeration of human capital in a city, the higher the wages, once we control for individuals' observable characteristics and other variables.

Figure 1. Correlation between regression-adjusted average wages and percentage of college graduate in cities. 2008:6- 2012:6.



Note: The vertical axis measures regression adjusted average wage in the city while the horizontal one measures share of college educated people (individuals with at least 15 years of education) with respect to the labor force and working-age population. Each dote corresponds to a city. Source: DANE-GEIH and Census 2005; author´s calculations.

The data used in the estimations below is a pooling of monthly cross-section household surveys between 2008 and 2012. Table 1 presents some descriptive statistics where the differences in the shares of college educated individuals are sizable when they are measured by either the workers in the labor force or people in the working-age population. It is noticeable that according to both measures, Bogotá is the city with the highest share, while Cúcuta holds the smallest share.

Our empirical approach consists of an estimation of the wage equation given by:

$$log(w_{ict}) = X_{ict}\beta_c + \vartheta n_{ct} + \alpha Z_{ct} + b_c + d_t + u_{ict} \qquad (4)$$

where w_{ict}, is the nominal wage of individual i in city c at time t, X_{ict} are observable individual characteristics, n_{ct} is the proportion of college educated workers in the working-age population of the city at time t, Z_{ct} are city characteristics (such as the housing rent, and so on), b_c are city fixed effects and d_t time effects. The parameter of interest, ϑ, is associated to the share of college

educated people, measured as the proportion of workers with 15 years of schooling or more in the working-age population.

Table 1. Summary statistics of salaried workers

City	College-educated people in the working age population (1)	College-educated workers in the labor force (2)
Barranquilla	0.220	0.149
Bucaramanga	0.213	0.138
Bogotá	0.260	0.191
Manizales	0.217	0.150
Medellín	0.198	0.146
Cali	0.189	0.114
Pasto	0.236	0.158
Cartagena	0.237	0.145
Montería	0.216	0.132
Villavicencio	0.185	0.111
Cúcuta	0.128	0.097
Pereira	0.159	0.111
Ibagué	0.202	0.123
Individual-level variables		**GEIH (2008:6-2012:6)**
Log of average hourly wage		7.981
Years of education		11.093
Years of potential experience		17.539
Age		34.626
Female share in salaried workers		0.433
Number of observations		374,334

Note: the share in column (1) is based on the 2005 Census. In column (2) it is based on *GEIH*.
Source: DANE; authors' calculations.

The residual u_{ict} is the sum of three terms: $u_{ict} = \mu_c \times \theta_i + \nu_{ct} + \varepsilon_{ict}$. The first is the product of a permanent unobservable component of human capital θ_i and a factor loading that represents the return to unobserved ability in city c, μ_c. This term might be associated to the personality traits that Acosta, Muller and Sarsoza (2015) link to the Big-Five skills that are related to the labor force participation and schooling decisions. As we mention in the introduction, this finding could be interpreted in a more ample way to consider that labor force participation –affected by the personality traits- can potentially affect the share of college educated workers. The second term comprises city-specific components including city labor demand shocks, ν_{ct}. The third is a transitory well-behaved component of wages, ε_{ict}.

Table 2 shows the results of the wage equations. Column (1) is the standard Mincer equation, which assumes that there are no spillovers at all. In this case, the private return is 7.5%, and housing

rent is positive and significant[19] as is the unemployment rate, a result that is counterintuitive according to the efficiency wages theory.[20] This specification also includes age, squared age, sex, time (quarter) fixed effects, production sector, relationship with the head of household, job position, and city dummies. When the share of college-educated workers in the working age population is taken into account in column (2), the size of the externality is 0.6869 which means that the social return is higher than the private return. According to this coefficient, an increase of one percentage point in the share of college-educated workers to labor force would increase wages by 0.6869%.[21]

Nevertheless, this coefficient might be biased upwards as predicted when individual ability is unobserved and is potentially correlated to the human capital agglomeration of the city. Thus, the first challenge that this approach has to face is the individual unobserved heterogeneity, since it is plausible that workers located in cities with high human capital may be different from those living in cities with low human capital. Under this circumstance, workers might not be randomly sorted across cities in the country because of some personality traits.

Since we take as valid the results of the structural estimation results of Acosta *et al*. (2015), some unobservable characteristics of individuals correlated to the human capital agglomeration. Thus, a correction for this potential source of inconsistency is needed as well as for any other type of changes in the labor demand in each city and reverse causality.[22] Therefore, to account for these sources of parameter inconsistency, we use an instrumental variables approach. The instruments are: the five-years lagged proportion of people aged between 15 and 25, the informal employment rate one year ago, and the log of unemployment rate one year ago. In each case we test the two properties of these instruments.

[19] This result would fit the model of Roback's (1982) prediction. In this case, this variable is measured as the rent component of the local CPI.
[20] The wage curve was successfully tested for Arango, Obando y Posada (2011).
[21] The estimates of Moretti (2004a) are 1.91, 1.67 and 0.47 for less than high-school, high-school graduates, and college graduates, respectively.
[22] There are two recent works whose results are worth mentioning. Roa (2008), by using the Life-quality Survey of 2003, founds that the migration decision for men is independent of earning distribution while the propensity to migrate is higher for less qualified women. According to her, people with very low schooling find more difficulties to enroll in the formal labor market. Barón (2103) found that migrants indeed respond to labor market conditions. However, the coefficients of the labor supply to such conditions are rather small in such a way that regional differences persist. The explanations may be related to the mobility costs.

Table 2. Effects of higher education on labor income. 2008:06-2012:06

Variables	Specification		
	(1) OLS	(2) OLS	(3) IV
Age	0.0378***	0.0372***	0.0372***
	(0.0005)	(0.0006)	(0.0006)
Schooling	0.0754***	0.0748***	0.0748***
	(0.0005)	(0.0005)	(0.0003)
Female	-0.0981***	-0.0937***	-0.0937***
	(0.0022)	(0.0024)	(0.0029)
Rent of houses	0.0078***	0.0023***	0.0021
	(0.0012)	(0.0006)	(0.0006)
Ln(Unemployment rate)	0.00767	0.0337**	0.0426***
	(0.0135)	(0.0147)	(0.0082)
College share		0.6869***	1.1293***
		(0.1762)	(0.2225)
R^2	0.498	0.505	0.505
Number of observations	373,787	330,891	330,891
Instruments			**First stage**
Proportion of people aged between 15 and 25 years old five years ago			0.0327***
			(0.0025)
Informal employment rate one year ago			-0.1741***
			(0.0008)
Ln(Unemployment rate one year ago)			0.0028***
			(0.0011)
Exogeneity test – Wu-Hausman			4.5409
***p*-value**			0.0331
Partial R^2 of excluded instruments			0.1300
***F* tests of excluded instruments**			16,482
Prob > *F*			0.0000
Overidentifying restriction test – Sargan			3.9888
***p*-value**			0.1361

Note: all regressions include age^2, time (quarter) fixed effects, production sector, relationship with the head of household, job position, and city dummies. Instruments comprise the five-years lagged proportion of people aged between 15 and 25 years old; the informal employment rate lagged one year, and log of the unemployment rate lagged one year. Standard errors are in parenthesis (clustered for the share of college-educated workers in the city in the case of OLS estimates); ***: $p<0.01$; **: $p<0.05$; and, *: $p<0.1$. Source: DANE-ECH-GEIH; authors' calculations.

The reasoning for using these instruments is as follows. The five-years lagged value of the proportion of young people (between 15 and 25 years old) is a leading indicator of the proportion of college educated people. While we cannot foresee any correlation between this variable (lagged five years) and the current error term, we recognize that more ancient age structure was desirable in order to avoid some remaining endogeneity that could still bias upwards the parameter of interest; however, the lack of information for 13 cities prevented us to use a better instrument. The other two instruments, the informal employment and the unemployment rates one year ago, might deter people from moving to any particular city;[23] in this sense, we expect that more educated

[23] Local unemployment rate might have some explanatory power on individual wages. However, according to the wage curve (Blanchflower y Oswald, 1995; and, Arango, Obando and Posada, 2011), this relationship -not strictly causal- in contemporary not lagged.

people make city allocation decisions based on this information. Thus, the three instruments are related to labor supply decisions.

Nevertheless, before running any two-stage least squares regression- instrumental variables model, we use the Wu-Hausman test to verify the endogeneity of the college share of educated workers. When the null hypothesis that this variable is exogenous cannot be rejected we use ordinary least squares. In this the case, the lack of evidence that the variable of interest is endogenous could be an indirect evidence of the low mobility of the labor force in Colombia as suggested by Barón (2013) and, for some population groups, by Roa (2008).

In the column (3) of Table 2, regardless of whether the instruments are significant in the first stage regression, the exogeneity test of the college share can be rejected at 5% level of significance (but cannot be rejected at 1%) while the Sargan test suggests that the instruments are valid. In addition, the *F* test of joint significance suggests that the instruments are significant in the first stage regression. Thus, for total workers there is a significant spillover of value of 1.3.

In Table 3 we turn to the analysis of the externality by level of schooling of the labor force. In this case, we present either the OLS or IV estimates depending on the *p*-value of the Wu-Hausman exogeneity test. Table 3 shows that age is almost equally valued for salaried workers irrespective of the schooling: the coefficient is between 0.028 and 0.039. However, the private returns to education are higher for college-educated workers (both with a finished career or currently enrolled) or with technical and technological education than for workers with less than 12 years of schooling. The reduction experienced by women's wage is stronger for people with high school at most.

Turning to the parameter of interest, the Wu-Hausman test suggests that the college share is only endogenous for lower educated people. When salaried workers are split among lower educated (11 years of education or less), medium-to-high (13 years of education or more), and high educated workers (15 years of education or more), the parameter of the college share is correctly estimated by IV for the former and by OLS for the latter two. In these cases, the spillovers are 0.923, 1.0662 and 1.2956, respectively.[24] That is, leaving everything else unchanged, the effect of human capital agglomeration is greater on the wages of workers with medium-to-high and higher educated

[24] These estimates might look sizable. However, the magnitude of the estimates by Sand (2013) is similar (see Tables 1 or 2).

workers. These results do not support the prediction of the model according to which the effect of college-educated workers on wages should be greater for lower educated workers if we consider not only the spillover, but also the imperfect substitution between the two types of workers. This, of course, deserves explanations that might be particular for the Colombian case.

Table 3. Income equations and the effect of higher education

Variables	Schooling <=11 IV	Schooling >=13 OLS	Schooling >=15 OLS
Age	0.0393***	0.0279***	0.0331***
	(0.0005)	(0.0012)	(0.0018)
Schooling	0.0421***	0.1283***	0.1038***
	(0.0004)	(0.0015)	(0.0020)
Female	-0.1085***	-0.0745***	-0.0755***
	(0.0027)	(0.0038)	(0.0050)
College share	0.9230***	1.0662***	1.2956***
	(0.2651)	(0.2199)	(0.2550)
R^2	0.2171	0.4847	0.3758
Number of observations	206,457	113,654	66,984
Tests for IV regressions			
Exogeneity test – Wu-Hausman	8.7401	0.2938	0.6732
***p*-value**	0.0031	0.5878	0.4119
Partial R^2 of excluded instruments	0.1304		
***F* tests of excluded instruments**	10,321		
Prob > *F*	0.0000		
Overidentifying restriction test - Sargan	2.1687		
***p*-value**	0.3381		

Note: all regressions include age^2, time (quarter) fixed effects, production sector, relationship with the head of household, job position, and city dummies. Instruments comprise the five-years lagged proportion of people aged between 15 and 25 years old; the informal employment rate lagged one year, and log of the unemployment rate lagged one year. Standard errors in parenthesis (clustered for the share of college-educated workers in the city in the case of OLS estimates); ***: $p<0.01$; **: $p<0.05$; and, *: $p<0.1$. Source: DANE-ECH-GEIH; authors' calculations.

In general, the reasons behind these results might be related to the careers or professions chosen by college-educated workers which may not be generating enough externalities for the less educated workers. This result can also arise due to the lack of interactions between high and low educated workers in the type of firms located in Colombia. Another explanation for this result can be related to the partial equilibrium approach we are using which only considers the change in the wage under a labor demand framework. Labor supply considerations might also be important. In the Appendix we present a wage equation derived from a simple partial equilibrium labor supply framework. In this case, an increase in n generates different predictions for the response in the wage. That is,

$$\frac{d\ ln(w_h)}{dn} = \frac{(1+\beta_h)}{[N_h^*/N - n(1+\beta_h)]} > 0$$

and,

$$\frac{d\ ln(w_l}{dn} = \frac{-(1+\beta_l)}{[N_l^*/N-(1-n)(1+\beta_l)]} < 0$$

Thus, we have that, as long as n increases, the leisure of college educated people decreases, but this can only occur if w_h increases. For low educated workers the reasoning for having a negative response of wage w_l given an increase of n, is due to the reduction in $(1-n)$; that is, a decrease in the share of low educated workers and an increase in the leisure of low educated workers occurs because of the reduction of w_l. Therefore, these derivatives might alter the predictions of section 2 above according to which: $d\ log(w_h)/dn < d\ log(w_l)/dn$, a result that does not hold in the case of our sample for Colombia.

By gender, Table 4 shows that, according to the Wu-Hausman test, the hypothesis that the share of college educate workers is exogenous cannot be rejected for men while for women it can be rejected except for those with more the 15 years of schooling.[25] Interestingly, the spillover is much higher for all women (1.7344), for those with a maximum of 11 years of schooling (1.5969) and for those with more than 12 years of schooling (1.9178)), when compared to the male counterpart. With respect to these, the OLS estimates suggests that low-educated workers do not benefit from the externality of the college-educated labor force while the highest external return corresponds to men with more than 14 years of schooling.

In summary, the evidence supports the hypothesis of an externality but in a heterogeneous way, depending on the educational attainments and gender of the population.

4. Three issues

Next, we analyze three aspects that naturally follow from the previous results. First, given the importance of Bogotá, the capital city of Colombia, we ask whether the results would change if we exclude this city from the analysis.[26] Second, in Colombia there is a public institution oriented to promoting higher education by means of credits and scholarships to undergraduate and graduate students. We inquire about the role played by this institution, the *Icetex*, in the effect of the externality in which are interested. Particularly, we ask whether the externality is either reinforced

[25] The distinction between men and women has been included given the substantial gender disparities of the labor market in Colombia (see Arango, Castellani and Lora, 2016).
[26] Bogotá, accounts for about 17% of the total population of the country and 25% of GDP.

or weakened by the interventions by *Icetex*. Thirdly, we relate the externalities of high education in the wages with the size of cities in Colombia. In this case, we observe that there is a positive relationship between the share of high-educated workers and the size of cities. We will now consider each issue briefly.

Table 4. Income equations by gender and the effect of higher education

Variables	Males				Females			
	All OLS	School<=11 OLS	School>=13 OLS	School>=15 OLS	All IV	School<=11 IV	School>=13 IV	School>=15 OLS
Age	0.0422***	0.0437***	0.0361***	0.0418***	0.0289***	0.0302***	0.0213***	0.0266***
	(0.0007)	(0.0007)	(0.0018)	(0.0027)	(0.0007)	(0.0009)	(0.0014)	(0.0023)
Schooling	0.0693***	0.0403***	0.1254***	0.0983***	0.0836***	0.0455***	0.1301***	0.1084***
	(0.0005)	(0.0006)	(0.0019)	(0.0028)	(0.0005)	(0.0008)	(0.0013)	(0.0027)
College share	0.6566***	0.1508	1.1748***	1.4978***	1.7344***	1.5969***	1.9178***	1.1341*
	(0.1910)	(0.2006)	(0.2835)	(0.3380)	(0.3410)	(0.4582)	(0.5108)	(0.2919)
R^2	0.4909	0.2328	0.4820	0.3713	0.5309	0.1965	0.4869	0.3759
Observations	187,522	132,029	50,253	29,199	143,369	74,428	63,401	37,785
Tests for IV regressions								
Exogeneity test - Wu-Hausman	0.0534	2.2243	1.5585	2.2928	10.6422	10.0512	3.7606	0.0391
***p*-value**	0.7092	0.1359	0.2121	0.1300	0.0011	0.0015	0.0525	0.8432
Partial R^2 of excluded instruments					0.1270	0.1250	0.1298	
***F* tests of excluded instruments**					6,947	3,543	3,149	
Prob > *F*					0.0000	0.0000	0.0000	
Sargan test					3.1841	2.5610	1.4758	
***p*-value**					0.2035	0.2779	0.4748	

Note: all the specifications are equal to column (3) in Table 2 and have the same controls. Instruments comprise the five-years lagged proportion of people aged between 15 and 25 years old; the informal employment rate lagged one year, and log of the unemployment rate lagged one year. Standard errors in parenthesis (clustered for the share of college-educated workers in the city in the case of OLS estimates). Source: DANE-ECH-GEIH; authors' calculations.

The size of the externality excluding Bogotá

Table 5 shows the results of regressions excluding observations corresponding to Bogotá. Interestingly, there is no evidence of endogeneity of the college-educated workers share. In this case, wages of less schooled workers are not affected by the share of the college-educated labor force, while the workers who benefited the most with the spillover are those with at least 15 years of education. Furthermore, the size of the externality is much higher than the estimation including Bogotá [see columns (2) and (3) of Table 3]. Although the explanation for these results is not trivial, the composition of local production and preferences of workers are the most likely candidates in the rationale.

Table 5. Income equations and the effect of higher education without Bogotá

Variables	All sample OLS	Schooling<=11 OLS	Schooling >=13 OLS	Schooling >=15 OLS
Age	0.0374***	0.0400***	0.0270***	0.0326***
	(0.0005)	(0.0007)	(0.0012)	(0.0019)
Schooling	0.0740***	0.0431***	0.1259***	0.1025***
	(0.0003)	(0.0006)	(0.0016)	(0.0019)
Female	-0.0956***	-0.1108***	-0.0754***	-0.0765***
	(0.0023)	(0.0035)	(0.0040)	(0.0053)
College share	0.8075***	0.2553	1.2736***	1.5470***
	(0.2311)	(0.1980)	(0.2319)	(0.2705)
R^2	0.5070	0.2234	0.4938	0.3895
Number of observations	290,156	182,818	98,213	57,580
Tests for IV regressions				
Exogeneity test - Wu-Hausman	0.3369	2.6568	0.0291	2.1865
***p*-value**	0.5616	0.1031	0.8644	0.1390

Note: all the specifications are equal to column (3) in Table 2 and have the same controls. Instruments comprise the five-years lagged proportion of people aged between 15 and 25 years old; the informal employment rate lagged one year, and log of the unemployment rate lagged one year. Standard errors in parenthesis (clustered for the share of college-educated workers in the city in the case of OLS estimates); ***: $p<0.01$; **: $p<0.05$; and, *: $p<0.1$. Source: DANE-ECH-GEIH; authors' calculations.

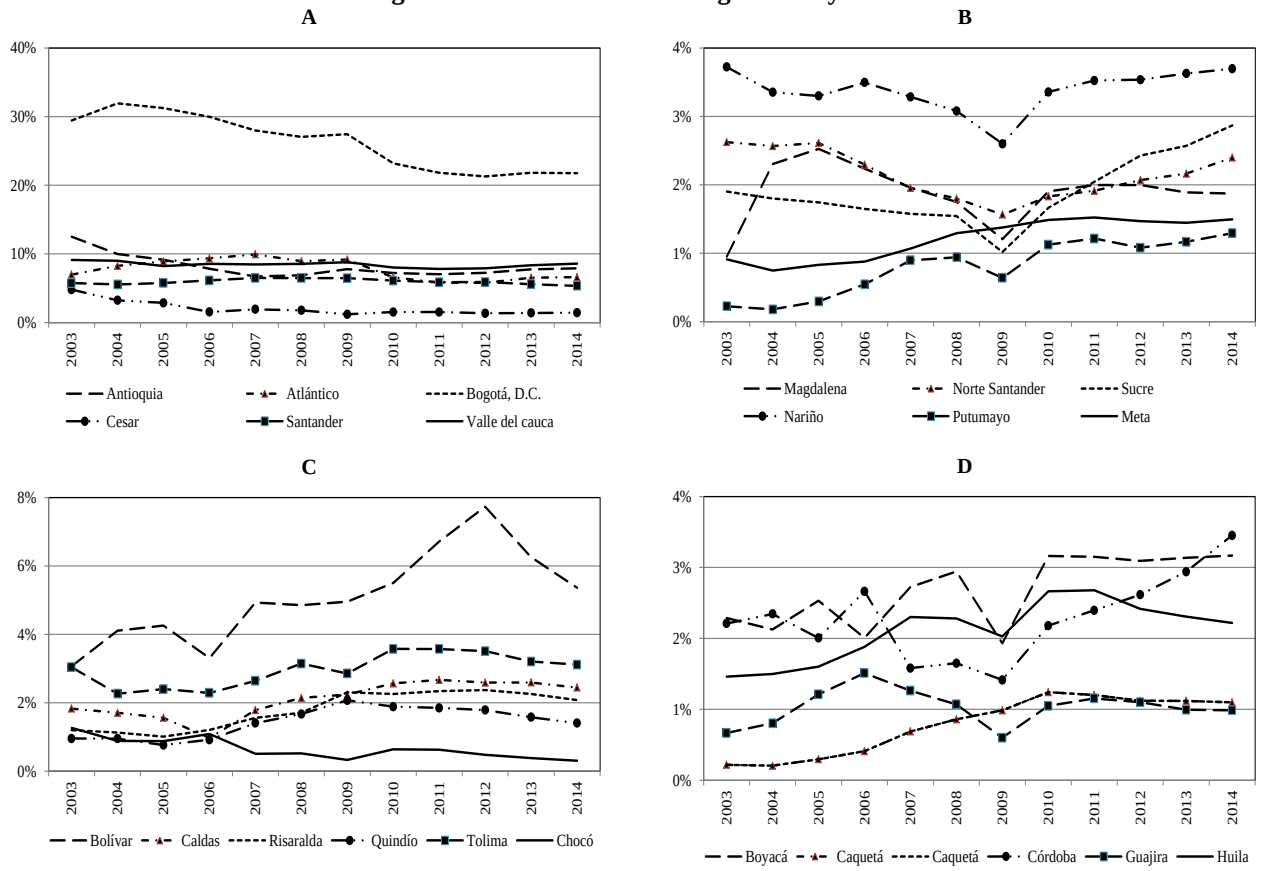
The effect of credits on college and graduate education

The *Icetex* is a public institution in charge of reducing liquidity constraints for students interested in pursuing undergraduate and graduate studies, the latter not only within the country, but also abroad. Thus, we ask whether *Icetex* is a determinant of wages and if so whether the loans it grants are contributing to boost or temper the externality related to the human capital agglomeration.

Figure 2 shows the distribution of the number of loans granted by *Icetex* to students in the provinces from 2003 up to 2014 with annual frequency. Panel A shows an interesting pattern: the almost monotonic reduction of the proportion of loans directed to Bogotá (included explicitly). Panels B and D show the break that occurred in 2009 with the path of credits directed to the provinces of Sucre, Nariño, Putumayo and Córdoba. In panel C, it is important to observe the behavior of the proportion of loans granted to the province of Bolívar.

The "share of the number of loans granted by *Icetex*" is included into the regression five-years lagged since it is the period an undergraduate program might take. Accordingly, the sign of the coefficient is positive and significant when the regression includes observations corresponding to Bogotá, although it is not significant for workers with more than 13 years of schooling (Table 6). The results, of the college share are similar to those of Table 3. The actions of *Icetex* help to increase the wages, except for those with more than 12 years of schooling.

Figure 2. Distribution of loans granted by Icetex



Source: Icetex; authors' calculations.

Table 6. Income equations and the effects of Icetex's interventions.

Variables	All OLS	Schooling <=11 IV	Schooling >=13 OLS	Schooling >=15 OLS
College share	0.7160***	0.8690***	1.0981***	1.3558***
	(0.1939)	(0.2622)	(0.2202)	(0.2627)
Share of loans granted by Icetex five years ago	0.3906***	0.5095***	0.3833	0.7927**
	(0.2226)	(0.1318)	(0.2780)	(0.3803)
R^2	0.5051	0.2172	0.4848	0.3760
Number of observations	330,891	206,457	113,654	66,984
IV regressions tests				
Exogeneity test - Wu-Hausman	3.0020	7.0329	0.0671	1.3313
***p*-value**	0.0832	0.0080	0.7956	0.2486
Partial R^2 of excluded instruments		0.1344		
***F* tests of excluded instruments**		10,681		
Prob > *F*		0.0000		
Sargan test		3.5316		
***p*-value**		0.1711		

Note: All the specifications are equal to column (3) in Table 2 and have the same controls. Instruments comprise the five-years lagged proportion of people aged between 15 and 25 years old; the informal employment rate lagged one year, and log of the unemployment rate lagged one year. Standard errors in parenthesis (clustered for share of loans granted by Icetex in the case of OLS estimates); ***: $p<0.01$; **: $p<0.05$; and, *: $p<0.1$. Source: DANE-ECH-GEIH; ICETEX; authors' calculations.

Now, when Bogotá is excluded from the sample (Table 7), the college share is not significant for low educated workers while it is greater for workers with higher schooling. Surprisingly, the coefficient of the loans granted by *Icetex* is positive. Thus, the institution's policy affects the local wages in the major cities mainly in municipalities other than Bogotá.

Thus, while *Icetex* has reduced the proportion of loans destined to Bogotá (where the spillover is smaller), for other cities (where the externality seems higher) such proportion has increased during the last decade or so. This, according to the level of the coefficients, has contributed to reduce wage differentials and, consequently, the geographical heterogeneity in the dimension of earnings in the labor market in Colombia, at least between Bogotá and the rest of the cities. It is very important to have the evidence in the sense that the *Icetex* is an externality generator.

Table 7. Income equations and the effects of Icetex's interventions (excluding Bogotá).

Variables	All OLS	Schooling <=11 OLS	Schooling >=13 OLS	Schooling >=15 OLS
College share	0.8384***	0.2852	1.3123***	1.6116***
	(0.1988)	(0.2249)	(0.2221)	(0.2679)
Share of loans granted by Icetex	0.5222**	0.5598***	0.5699*	1.0505***
	(0.2369)	(0.1902)	(0.3293)	(0.4379)
R^2	0.5070	0.2234	0.4938	0.3893
Number of observations	290,157	182,818	98,213	57,580
IV regressions tests				
Exogeneity test - Wu-Hausman	0.1076	2.1638	0.1314	2.6801
***p*-value**	0.7429	0.1413	0.7169	0.1014

Note: All the specifications are equal to column (3) in Table 2 and have the same controls. Instruments comprise the five-years lagged proportion of people aged between 15 and 25 years old; the informal employment rate lagged one year, and log of the unemployment rate lagged one year. Standard errors in parenthesis (clustered for share of loans granted by Icetex in the case of OLS estimates); ***: $p<0.01$; **: $p<0.05$; and, *: $p<0.1$. Source: DANE-ECH-GEIH; ICETEX; authors' calculations.

The college share and the size of cities

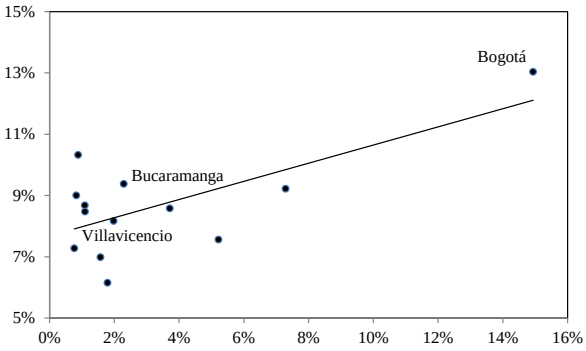
This subsection addresses the issue about of the location of college-educated people across the thirteen cities considered in the analysis. In fact, Figure 3 shows the correlation between the average 2008-2013 of college share and the proportion of population size according to the 1993 and 2005 censuses. In both cases, the correlation is positive including and not includingexcluding Bogotá. Thus, the agglomeration of human capital is high in those cities where the population size of cities is also high.

This result is in line with Wheeler (2006), who provides evidence in the sense that human capital growth is correlated to population size and the existing stock of college-educated labor.

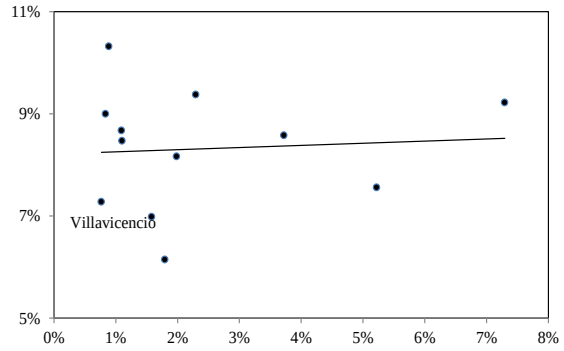
That is, cities with larger populations and workers with higher education (bachelor degrees) exhibit higher rates of human capital growth than cities with less population and workers with higher education.

Figure 3. Size of cities as a proportion of total population and college share

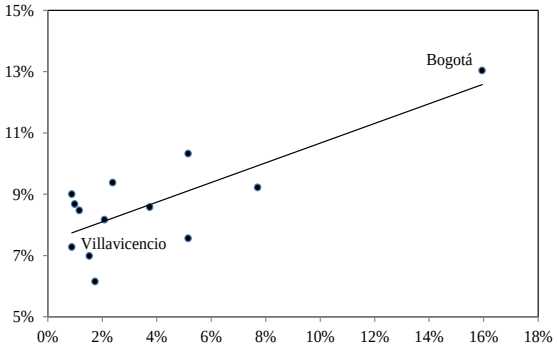
City size in 1993 and average 2008-2013 college share



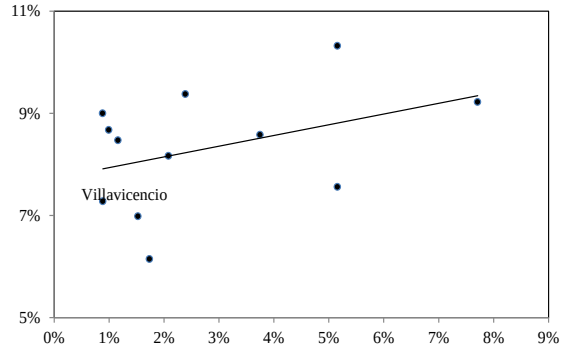
City size in 1993 and average 2008-2013 college share without Bogotá



City size in 2005 and average 2008-2013 college share



City size in 2005 and average 2008-2013 college share without Bogotá



Source: DANE; authors' calculations.

Table 8 shows the results for income equations with population size as a proportion of total population, using the 1993 and 2005 censuses information of city sizes instead of the shares of college-educated workers. Given the value of coefficients, city size seems to be a predictor of the spillover at hand; moreover, the coefficients are now more homogenous among men and women than in the cases of the shares studied above, mainly in people with thirteen years of education and over. We are not claiming that this is a robust result. Instead, we believe that it is an indicator of human capital agglomeration including not only the quantity, but also its diversity, and that it is worthwhile to study this issue in depth.

Table 8. Income equations and the effect of city size. OLS estimates

Variables	Educ<=11	Educ>=13	Males			Females		
			All	Educ<=11	Educ>=13	All	Educ<=11	Educ>=13
City size in 1993	0.7966***	1.0541***	0.8914**	0.7454**	1.0066***	1.0310***	0.8958***	1.1152***
	(0.2481)	(0.2366)	(0.2958)	(0.2897)	(0.2500)	(0.2181)	(0.1879)	(0.2340)
City size in 2005	0.7363***	0.9748***	0.8252**	0.6903**	0.9305***	0.9528***	0.8259***	1.0321***
	(0.2276)	(0.2192)	(0.2726)	(0.2661)	(0.2315)	(0.2014)	(0.1722)	(0.2166)

Note: standard errors in parenthesis (clustered for citysize). Source: DANE-GEIH; authors' calculations.

5. Conclusions

The education of individuals generates private returns as well as external effects, which jointly render social returns. Externalities can be technological, pecuniary, related to production and consumption, or related to market size. In this document, we verify the hypothesis that the share of college-educated workers in the working-age population of the cities generates positive spillovers in the form of higher wages.

The empirical approach involves both IV and OLS estimations of income equations. The former is used when, according to the Wu-Hausman test, the hypothesis that the share of college-educated workers in the working-age population is exogenous can be rejected. This happens when workers and firms are not randomly sorted across the cities. To achieve an accurate identification of the spillover of human capital agglomeration, we use the proportion of young people five years ago and some lagged labor market outcomes. When the test cannot reject the null hypothesis, the OLS estimation is carried out.

The average size of the externality is between 1.13 and 0.716, when the number of loans of *Icetex* is considered, (Tables 2 and 6). This means that an increase of one percentage point in the share of college-educated to working-age population would increase wages by 1.13% (0.716%). In comparison with high educated workers, low educated ones receive a smaller effect of the externality; this result, at odds with the labor demand approach, might be explained by some labor supply features not incorporated by the former. The size of the externality is higher for male than female workers.

There are three important results to underscore. First, the spillover is higher in cities other than Bogotá. Second, the *Icetex's* actions through allocation of loans for funding undergraduate and graduate education also affect wages. Moreover, granting a higher proportion of loans to provinces other than Bogotá, the *Icetex* promotes the formation of human capital in other sites of the country

where the spillover is higher. The increasing supply of high educated workers induced by *Icetex's* policies, is reducing the wage heterogeneity between other cities and Bogotá. Third, the share of college-educated workers is positively related to the size of the cities. Thus, wages are higher in more populated cities, in part due to the spillover.

Heterogeneity of wages and returns to education across regions in Colombia is one of the outcomes in which the labor market exhibits most disparities. It also shows differences across regions in quantity variables such as unemployment rates, and so on. This paper offers a partial explanation of the differences in wages and returns on education, and it should trigger other reactions regarding the effects of quantities on the labor market.

References

Acemoglu, D., 1996, A Microfoundations for Social Increasing Returns in Human Capital Accumulation, The Quarterly Journal of Economics, 779-804.

Acemoglu, D., and Angrist, J., 1999, How Large are the Social Returns to Education? Evidence from Compulsory Schooling Laws, NBER, Working Paper 7444.

Acosta, P, Muller, N., and Sarzosa, M., 2015, Beyond Qualifications, Returns to Cognitive and Socio-Emotional Skills in Colombia, Policy Research Working Paper 7430, World Bank Group, Social Protection and Labor Global Practice Group, September.

Arango, L.E., 2013, Mercado de trabajo de Colombia: suma de partes heterogéneas, in Arango and Hamann (eds.), El mercado de trabajo en Colombia: hechos, tendencias e instituciones, Banco de la República, Chapter 4, pp. 167-202.

Arango, L.E., Castellani, F., and Lora, E., 2016, *Desempleo femenino en Colombia*, IADB and Banco de la República.

Arango, L.E., Obando, N., and Posada, C.E., 2011, Sensibilidad de los salarios al desempleo regional en Colombia: nuevas estimaciones de la curva de salarios, in Formación de precios y salarios, López E. and M.T. Ramírez (eds.), Formación de precios y salarios, Banco de la República, Chapter 23.

Barón, J.D., 2013, Sensibilidad de la oferta de migrantes internos a las condiciones del mercado laboral en las principales ciudades de Colombia, in Arango and Hamann (eds.), El mercado de trabajo en Colombia: hechos, tendencias e instituciones, Banco de la República, Chapter 14, pp. 589-622.

Becker, G., 1964, Human Capital: A theoretical and Empirical Analysis with Special Reference to Education, NBER, Third Edition, 1993.

Bernal, R., Sensibilidad de la oferta de migrantes internos a las condiciones del mercado laboral en las principales ciudades de Colombia, in Arango and Hamann (eds.), El mercado de trabajo en

Colombia: hechos, tendencias e instituciones, Banco de la República, Comments to chapter 14, pp. 623-626.

Bettencourt, L.A.M, Samaniego, H., and Youn, H., 2014, Professional diversity and productivity of cities, Scientific Reports, 4: 5393, 1-6.

Blanchflower, D.G., and Oswald, A.J., 1995, An introduction to the Wage Curve, Journal of Economic Perspectives, Vol. 9, num. 3, pp.153-167.

Bratti, M., and Leombruni, R., 2014, Local human capital externalities and wages at the firm level: Evidence from Italian manufacturing, Economics and Education Review, 41, 161-175.

Cárdenas, C., Hernández, A., and Torres, J.E., 2014, An Exploratory Analysis of Heterogeneity on Regional Labour Markets and Unemployment Rates in Colombia: An MFACT approach, Borradores de Economía, No. 802, Banco de la República.

Castellar, C. E., and Uribe, J. I., 2001, Una aproximación econométrica a la tasa de retorno social de la educación, Revista sociedad y economía, 1.

Cicconne, A., and Peri, G., 2006, Identifying Human-Capital Externalities: Theory with Applications, Review of Economic Studies, 73, 381-412.

Dee, T.S., 2003, Are there civic returns to education?, NBER WP 9588.

Díaz, A.M., 2013, The Employment Advantages of Skilled Urban Municipalities in Colombia, Ensayos sobre Política Económica, 31, 70, 315-366.

Elhorst, J.P., 2003, The mystery of regional unemployment differentials: Theoretical and empirical explanations, Journal of Economic Surveys, 17 (5), 709-748.

Espinosa, A., 2003, Migraciones regionales y mercado laboral en Colombia, 1973-1993, Serie de estudios sobre la Costa Caribe núm. 18, Universidad Jorge Tadeo Lozano, Seccional del Caribe, Cartagena.

Galvis, L., 2002, Integración regional de los mercados laborales en Colombia, 1984-2000, en Macroeconomía y regiones, tomo 25, pp. 218–255. Banco de la República.

Galvis L. A., 2010, Diferenciales salariales por género y región en Colombia: Una aproximación con regresión por cuantiles. Revista de Economía del Rosario, 13 (2), 235-277.

Gamarra J. R., 2005, ¿Se comportan igual las tasas de desempleo de las siete principales ciudades colombianas?, Documentos de Trabajo Sobre Economía Regional, No. 55, Banco de la República, Cartagena.

Gleaser, E. and Saks, R., 2006, Corruption in America, Journal of Public Economics 90, 1053 – 1072.

González, F., Guzmán, C., and Pachón, A., 1998, Productividad y retornos sociales del capital humano: Microfundamentos y evidencia para Colombia, Archivos de Macroeconomía, 98, DNP.

Guataquí, J. y Roa, M., 2010, Caracterización histórica de la migración interna en Colombia en el siglo XX y en el censo nacional de población 2005, Bogotá, Colombia. II Congreso de Economía Colombiana, Universidad de los Andes, 28 Septiembre.

Katz, L., and Murphy, K., 1992, Changes in relative wages, 1963 – 1987: supply and demand factors, The Quarterly Journal of Economics, 35-78.

Lochner, L., and Moretti, E., 2003, The effect of education on crime: Evidence from prison inmates, arrests, and self-reports, UCLA.

Lucas, R. E., 1988, On the mechanics of economic development, Journal of monetary economics, 22(1), 3-42.

Manning, A., 2004, We Can Work It Out: The Impact of Technological Change on the Demand for Low-Skill Workers, Scottish Journal of Political Economy, 51(5), 581-608.

Mazzolari, F. and Ragusa, G., 2013, Spillovers from high-skill consumption to low-skill labor markets, Review of Economics and Statistics, 95(1), 74-86.

Mondragón, C., Peña, X., and Wills, D., 2013, Rigideces laborales y salarios en los sectores formal e informal en Colombia in Mercado de trabajo en Colombia: hechos, tendencias e instituciones, Chapter 5, Arango L.E and F. Hamann (eds.), Banco de la República, 2013, pp 631-668.

Moretti, E., 2004a, Estimating the social return to higher education: evidence form longitudinal and repeated cross-sectional data, Journal of Econometrics, 121, 175-212.

Moretti, E., 2004b, Human Capital Externalities in Cities, Handbook of Regional an Urban Economics, Vol. 4, Chapter 51, Elsevier, 2243-2291.

Rauch, J.E., 1993, Productivity Gains from Geographic Concentrations of Human Capital: Evidence from the Cities, Journal of Urban Economics, 34, 380-400.

Roa, M., 2008, ¿Migran los colombianos para mejorar sus condiciones laborales? Evidencia de la hipótesis de selección para Colombia 2003, Archivos de economía, Departamento Nacional de Planeación.

Roback, J., 1982, Wages, rents and the quality of life, Journal of Political Economy, 90 (6), 1257-1278.

Sand, B.M., 2013, A re-examination of the social returns to education: Evidence from U.S. cities, Labour Economics, 24, 97-106.

Schultz, T.P., 1988, Education Investments and Returns, Handbook of Development Economics, vol. 1, Chapter 13, 543-630.

Viinikainen, J, and Kokko, K., 2012, Personality traits and unemployment: Evidence from longitudinal data, Journal of Economic Psychology, 33, 1204-1222.

Wheeler, C.H., 2006, Human Capital Growth in a Cross Section of U.S. Metropolitan Areas, Federal Reserve Bank of St. Louis Review, March/April, 113-132.

Appendix

We start by assuming that in the economy there two types or workers, high (h) and low (l) educated. Both maximize the utility which depends on consumption (c) and leisure (N^O) subject to a budget constrain given by labor income (Nw) and nonlabor income (rK). Total time availability (N^*) is split between leisure and labor (N_i, $i = h, l$).

In the case of the higher educated workers, also owners of capital, we have:

$$Max\ U = \ln c_h + \beta_1 ln N_h^O$$
$$\text{s.t.} \quad c_h = N_h w_h + rK$$
$$N_h^* = N_h^O + N_h$$

The maximization process allows us to obtain a wage equation given by:

$$\ln w_h = \beta_h ln(K/N) - ln[N_h^*/N - n(1+\beta_h)]$$

where $n = N_h/N_l + N_h = N_h/N$. Accordingly,

$$\frac{d\ ln(w_h)}{dn} = \frac{(1+\beta_h)}{[N_h^*/N - n(1+\beta_h)]} > 0$$

for moderate values of β_h. Similarly, for lower educated workers:

$$Max\ U_l = \ln c_l + \beta_l ln N_l^O$$
$$\text{s.t.} \quad c_l = N_l w_l + A$$
$$N_l^* = N_l^O + N_l$$

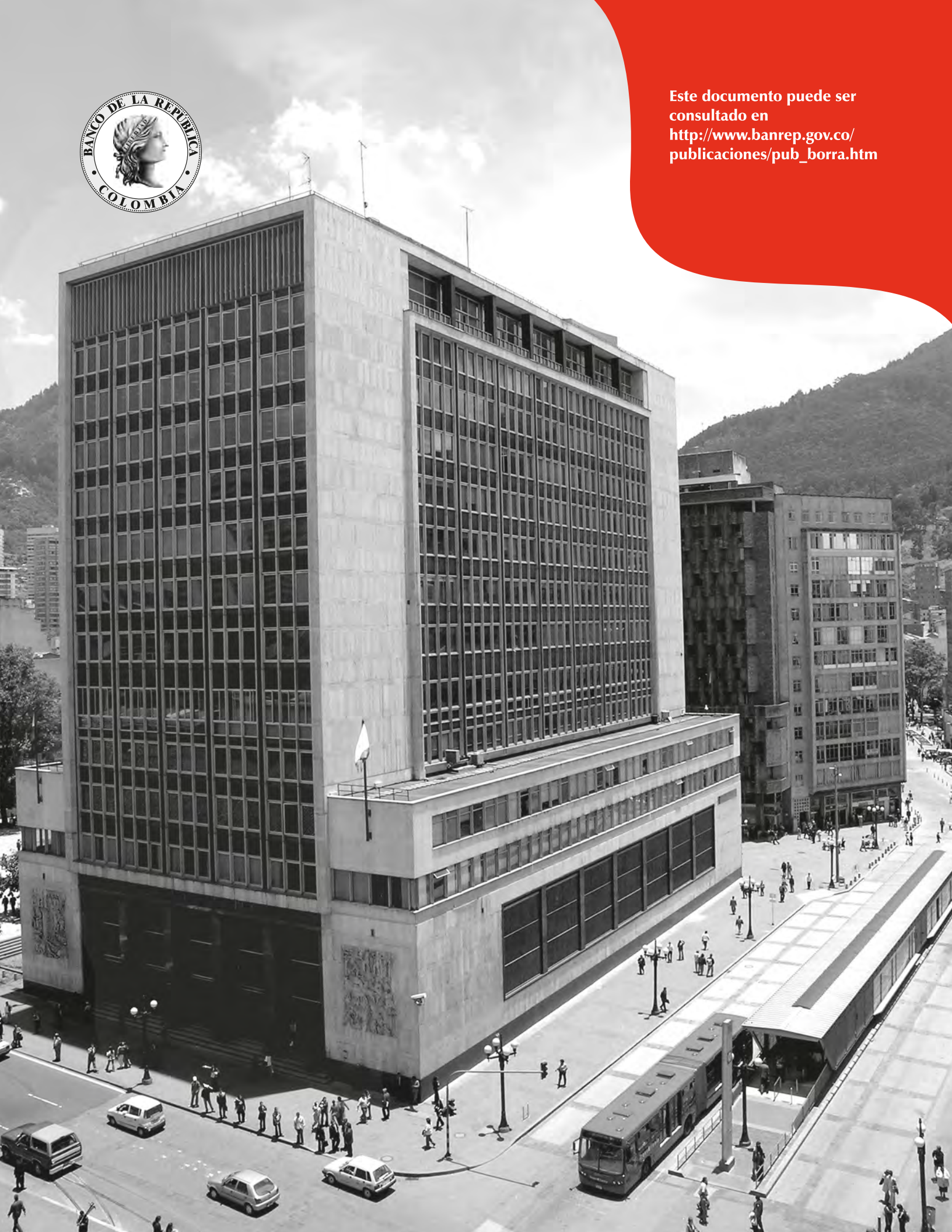
where A corresponds to a nonlabor income of low educated workers. The wage equation turns to,

$$\ln(w_{l)} = \beta_l ln(A/N) - ln[N_l^*/N - (1-n)(1+\beta_l)]$$

Therefore,

$$\frac{d\ ln(w_l)}{dn} = \frac{-(1+\beta_l)}{[N_l^*/N - (1-n)(1+\beta_l)]} < 0$$

Thus, we can observe that as long as s increases, N_h^O reduces but this can only occur if the wage of higher educated workers, w_h, increases. For low educated workers the intuition for having a negative response of wage w_l given an increase of n, is due to the reduction in $(1-n)$; that is, a decrease in the share of low educated workers and an increase in N_l^O occurs because of the wage reduction.



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