

Double Penalty in Returns to Education: Informality and Educational Mismatch in the Colombian Labour Market

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ABSTRACT *This article examines the returns to education taking into consideration the existence of educational mismatches in the formal and informal employment of a developing country. Results show that the returns of surplus, required and deficit years of schooling are different in the two sectors. Moreover, they suggest that these returns vary along the wage distribution, and that the pattern of variation differs for formal and informal workers. In particular, informal workers face not only lower returns to their education, but suffer a second penalty associated with educational mismatches that puts them at a greater disadvantage compare to their formal counterparts.*

1. Introduction

A distinctive feature of almost all Latin America and the Caribbean labour markets is the existence and persistence of a large informal sector. In fact, half of the employed population of this region worked in informal jobs at the end of the first decade of this century (International Labour Organization [ILO], 2011). Informal employment embraces a variety of heterogeneous activities, such as self-employment entrepreneurs, salaried workers of large and small firms, and unpaid domestic workers. Informal employment generally involves that workers are trapped in unproductive activities, with inferior working conditions, lack of social security and lower earnings. A seemingly stylised fact, found in past studies about labour market segmentation, is that informal-sector workers, even if equally productive, are subject to lower remuneration than formal-sector workers. So even when more highly educated workers tend to be more productive than less educated counterparts, schooling may not be the key for higher paying jobs if the labour market is segmented.

A number of explanations have been offered to explain why some earning-relevant characteristics, for example, education, are better rewarded in the formal sector than in the informal sector. An important bulk of these explanations is based on a segmented view of the labour market. For instance, the presence of extremely restrictive labour market institutions and strict regulation of entry into the formal sector could pose a possible cause, so that some workers that do not have access to the formal

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sector are forced to accept informal sector jobs characterised by inferior earnings (see Fields, 1975). However, several more recent studies postulate, for both firms and workers the decision of being formal turns out to be extremely costly, due to the non-labour costs associated with health and pension contributions, payroll taxes, commuting subsidies, among others, which significantly increases the attractiveness of informal activities. Maloney (1999), for instance, introduces a standpoint in which workers may find informal-sector employment a desirable alternative due to inefficiencies in the provision of public services, that is, health and pension, or because their level of human capital do not fulfil the requirements for performing formal jobs. In the last case, a wage penalty for informal-sector employment may be due to sorting, where those with low levels of human capital are also those more likely to work in the informal sector (Tokman, 1982). This type of sorting may result from the fact that firms in the informal sector have limited access to financing and employers choose to substitute physical capital for low-skill labour (see, for example, Amaral & Quintin [2006]).

However, none of the former studies have considered one aspect which can affect the wage gap between formal and informal workers; that is, the way workers match their acquire education to the one required to perform their job. One important feature that raises concern in developed countries is the existence of a discrepancy between the education attainment of workers and the skill requirements of jobs, commonly known as education–occupation mismatch (Organisation for Economic Co-operation and Development [OECD], 2011). The incidence and labour market effects of educational–occupation mismatch, especially overeducation, have received increasing attention in the literature for developed countries (Germany, the Netherlands, Spain, the United Kingdom, Portugal, Hong Kong and the United States).¹ Recently some attention has also been paid for some developing countries (Mexico, Pakistan, India, the Philippines, Thailand and Colombia).² Several of these studies have shown that the incidence of education–occupation mismatch varies significantly with the method used to measure required education, hence overeducation. However, while the choice of the method can have an effect on the incidence of the phenomenon under analysis, the effect on earnings is not altered (Groot & van den Brink, 2000). So, independently of the method used, a number of studies that estimated the effects of overeducation on earnings for developed and developing countries found that overeducated workers tend to earn higher returns to their years of schooling than co-workers who are not overeducated, but lower returns than workers with similar education who work in jobs that require the level of education that they possess.

In a previous study, Herrera-Idárraga, López-Bazo, and Motellón (2012), using micro-data for Colombia, find that after controlling for other characteristics and correcting for endogeneity, informal salary workers are more likely to be overeducated than formal workers. Thus, it is possible that the formal–informal wage gap is driven, at least in part, by a less satisfactory matching of education–occupation in the informal sector and by the penalisation in terms of wages that is derived from this mismatch. Actually the aim of this article is to re-examine the wage gap between formal and informal workers taking into consideration that education–occupation mismatch is present in both sectors, using the case study of Colombia.

Colombian labour market constitutes a good case of study for several reasons. First, informality today is at centre of economic and political debates in the country because the high levels that prevail. Second, in Colombia there is a high incidence of the minimum wage; that is, a relatively high proportion of formal sector employees, 34.6 per cent, receive a salary similar to the minimum (Arango, Herrera, & Posada, 2008), which points to the existence of important labour market rigidities. Third, previous studies have found overeducation to exist in Colombia (Castillo, 2007; Dominguez-Moreno, 2009; Herrera-Idárraga et al., 2012; Mora, 2005).

This study contributes to the literature on informality and education–occupation mismatch by gauging whether the return to years of required education, years of surplus education and years of deficit education differ across formal and informal sectors. If they do differ and if salaried informal workers are more penalised in terms of wages in the presence of educational mismatches than their formal counterparts, then we can infer that part of the formal–informal wage gap might be originated in such a difference. A similar approach is adopted in Chiswick and Miller (2008) in their analysis of the difference in returns to education between native and foreigners in United States. These authors

find that the lower payoff to schooling for foreign-born workers is due to undereducation (linked with positive self-selection in immigration among immigrants with low levels of schooling) rather than to overeducation (related to the less-than-perfect international transferability of human capital). Under the same line, Ren and Miller (2012) also use the over-under education framework for analysing the difference in returns to schooling between men and women in China. As far as we know, the idea of distinguishing the difference in returns from correct, over and deficit years of education for formal and informal workers is a novel contribution, as there is no previous study that considered this distinction in all analyses of which we know about informality.³

The empirical analysis consists of examining the returns to education, taking into consideration the existence of educational mismatches in the formal and informal sector. For this purpose we first estimate the standard Duncan and Hoffman (1981) specification (so called ORU wage equation) at the mean, using ordinary least square (OLS), and controlling for a rich set of observable individual and firm characteristics. Then, we examine whether the returns to education for each of the education–occupation mismatch are not uniform along the wage distribution by using quantile regression estimation. In both cases the endogeneity sector choice is addressed.

A potential drawback of this study is the pernicious effect on the estimates caused by some unobserved characteristics, such as ability and quality of education, which affect both wages and education–occupation mismatch. As in previous studies in the field, we cannot guarantee that these unobservables do not contaminate the estimate of the effect of required, surplus and deficit education. As indicated in Leuven and Oosterbeek (2011), neither the standard fixed-effect estimator nor the one based on instrumental variables are suitable in providing consistent estimates of the parameters of the ORU wage equation. Accordingly, interpretation of the estimates in the paper as causal effects should be made cautiously. In any case, it is worth noting that as long as these unobservables determine the sector in which the individual is working, our empirical strategy is somehow controlling their effects.⁴

Results for Colombia show that: (1) consistent with previous literature, the return to an overeducated year is lower than the return to a required year of education, both in the formal and informal sector; (2) formal workers that possess the education required to do their job have a higher return to their education, around double, compared with their informal counterparts; (3) moreover, they have a higher return than informal workers who are overeducated; (4) the return to an overeducated year of education is higher in the formal sector than in the informal sector; and (5) the wage penalty of deficit schooling is almost the same across the two sectors. Moreover, using quantile regression estimations we show that (1) these returns vary along the wage distribution and (2) the pattern of variation along the distribution is not the same for formal and informal workers. More specifically, the returns to required education increases along the wage distribution for both type of workers, but the increase is more noticeable for formal workers. While returns to surplus education increases along the wage distribution for formal workers, they almost remain constant for informal workers. We therefore conclude that adding measures of educational mismatch gives important information to the analysis of the formal–informal wage gap. In particular, we show that in the informal sector not only the returns to correct years of education are lower, but the penalty that informal workers face due to educational mismatches, especially overeducation, in terms of wages are considerable higher than for their formal counterparts. We also discuss the role that differences in unobservable skills and quality of education between formal and informal workers may have in explaining the gap in the above-mentioned returns.

The rest of the article is organised as follows. The next section gives a description of the data and some selected descriptive, while the empirical approach is presented in Section 3. Section 4 summarises the results regarding the estimates of the empirical models, and finally Section 5 concludes.

2. Dataset and Descriptive Analysis

We use data from the Colombian Household Survey (CHS), a repeated cross-section conducted by the National Statistics Department (DANE). The survey gathers information about employment conditions

for population aged 12 or more, including income, occupation and industry sector at two-digit level, in addition to the general population characteristics such as sex, age, marital status and educational attainment, and covers the 13 major metropolitan areas in Colombia.

In this study, a sample of 34,626 working individuals was drawn from the 2010 CHS. The analysis was restricted to salary workers aged between 15 and 60 years that were not carrying out formal studies and who reported working more than 16 hours per week. We did not include self-employed and employers' workers in the analysis because their source of income is a combination of labour and physical capital and therefore may not be compared with earnings of other employees. Apart from this, self-employed workers' earnings would be expected to have a greater measurement error. Also, while comparing self-employed informal workers to their formal counterparts may be of interest, it has been shown in previous studies that self-employed in the informal sector corresponds more with a voluntary entry, while informal salaried work may correspond more closely to the standard queuing view, especially for younger workers (Bosch & Maloney, 2010; Perry et al., 2007). Excluding self-employed resulted in dropping 16,941 individuals. We also exclude public employees from the sample, since, by nature, they belong to the formal sector and their wages might reflect institutional arrangements. After excluding observations with missing values or inconsistencies for the selected regressors, over 13,797 individuals remained in our sample.

We classify workers as formal or informal according to whether they are covered by the social security system or not, in line with the definition proposed by the Seventeenth International Conferences of Labour Statisticians (ICLS).⁵ Thus, we define workers as formal if they contribute both to health and old-age insurances. For the purpose of measuring the incidence of the education–occupation mismatch we define required education using the statistical method in its mean and mode version. Under the statistical method, required education is defined as the mean or mode level of schooling for each occupation (two-digit ISCO-68 classification). Individuals are classified as overeducated (undereducated) for a particular occupation if their level of education is higher (lower) than the required education. In the mean measure a worker is overeducated or undereducated if their completed level of schooling deviates by one standard deviation from the mean in their occupation.⁶ Regarding earnings, we have combined information from gross monthly income and worked hours in order to obtain gross hourly wages.

Table 1 contains mean hourly wages by job type and educational mismatch. As can be seen, informal workers are likely to earn less than formal workers; formal workers earn 78 per cent more than informal workers earn for the total sample. This large wage differential found here is in line with the findings of several other studies for other countries, and so far has been the centrepiece of the empirical analysis in the past. If formal and informal workers are classified by educational mismatch the wage gap is not the same across the different categories. For instance, overeducated formal workers earn 90 per cent more than informal overeducated workers, while undereducated formal workers earn 40 per cent more than their informal peers. The formal–informal wage gap is also higher for the overeducated than for workers correctly matched in terms of education.

Table 1 also presents the formal–informal wage gap at the different quartiles. As it can be seen the wage gap is not homogeneous along the wage distribution and across the different education–occupation mismatches. The first thing to be noticed is that hourly wages at the lower quartile for correct and overeducated formal workers are both equal to the minimum wage,⁷ while an undereducated formal worker perceives a wage slightly lower.⁸ This finding conforms to the notion that the minimum wage is binding in the formal sector. The formal–informal wage gap at the lower quartile of the wage distribution is considerably lower for overeducated workers compared to correct and undereducated workers. This could be indicating that a formal worker in the lower part of the distribution and regardless of his education will be rewarded with a wage similar to the minimum wage, while informal wages are determined freely. This possibility of setting wages freely allows the informal sector to pay a considerably lower wage to correct and undereducated workers, while somehow rewarding overeducated workers. In contrast, at the middle and, particularly, at the upper part of the distribution, the formal–informal wage gap is substantially higher for overeducated workers compared to correct and undereducated workers. Thus, this simple preliminary evidence, at the mean and at the

Table 1. Gross hourly wage gap at the mean and at the different quartiles

| | All | | Formal | | Informal | | |
|---------------|----------|----------|----------|----------|----------|----------|-------|
| Mean | Mean | SD | Mean | SD | Mean | SD | WF/WI |
| Overeducated | 4,627.06 | 3,847.00 | 5,170.34 | 4,116.13 | 2,714.70 | 1,602.93 | 1.90 |
| Correct | 3,588.28 | 2,747.15 | 4,125.16 | 3,007.49 | 2,366.05 | 1,409.71 | 1.74 |
| Undereducated | 2,665.47 | 1,364.69 | 3,131.68 | 1,443.82 | 2,197.83 | 1,097.70 | 1.42 |
| Total | 3,662.58 | 2,894.68 | 4,240.56 | 3,193.62 | 2,379.11 | 1,396.24 | 1.78 |
| | | | | | | | |
| | All | | Formal | | Informal | | WF/WI |
| Quartiles | | | | | | | |
| Lower – q25 | | | | | | | |
| Overeducated | 2,503.47 | | 2,503.47 | | 1,944.45 | | 1.29 |
| Correct | 2,333.33 | | 2,503.47 | | 1,600.00 | | 1.56 |
| Undereducated | 1,944.45 | | 2,417.59 | | 1,555.56 | | 1.55 |
| Total | 2,333.33 | | 2,503.47 | | 1,633.33 | | 1.53 |
| Middle – q50 | | | | | | | |
| Overeducated | 3,111.11 | | 3,402.78 | | 2,434.78 | | 1.40 |
| Correct | 2,700.35 | | 3,004.17 | | 2,187.50 | | 1.37 |
| Undereducated | 2,503.47 | | 2,654.46 | | 2,097.62 | | 1.27 |
| Total | 2,722.22 | | 3,004.17 | | 2,216.67 | | 1.36 |
| Higher – q75 | | | | | | | |
| Overeducated | 5,185.19 | | 6,003.47 | | 2,986.67 | | 2.01 |
| Correct | 3,888.89 | | 4,375.00 | | 2,722.22 | | 1.61 |
| Undereducated | 3,004.17 | | 3,402.78 | | 2,561.36 | | 1.33 |
| Total | 3,888.89 | | 4,612.03 | | 2,731.06 | | 1.69 |

Notes: Gross hourly wage in pesos. SD denotes standard deviation. WF/WI is the formal–informal wage ratio.

different quartiles, indicates that educational mismatch may be a key aspect in order to get a better understanding of the formal–informal wage gap.

As complementary descriptive evidence, Table A1 in the Online Appendix presents some basic summary statistics concerning the distribution of the observed workers' and firms' characteristics that may be driving the earnings differentials between formal and informal workers. Figures in that table confirm that workers in the two employment sectors differ markedly with respect to the incidence of educational mismatch and the other observed characteristics.

3. Wage Estimates – Empirical Strategy

An important number of former studies that intended to measure the formal–informal sector wage gap have simply estimated a Mincerian wage equation using OLS. The framework for the empirical analysis is a model in which the wage of an individual i in sector j is given by:

$$W_{ij} = \alpha_j S_{ij} + \beta_j X_{ij} + \varepsilon_{ij} \quad (1)$$

where W_{ij} denotes the log of the hourly wage of the individual i in sector j , formal (F) or informal (I), S_{ij} the years of acquired education, X_{ij} denotes the set of other characteristics (for example experience, tenure, gender) that affect the wage of this individual; α_j is the return to years of acquire education and β_j is a vector of prices or returns associated with other characteristics that affect wages. Finally, ε_{ij} is the error term for individual i in sector j .

The typical specification adopted to estimate the effect on earnings of education–occupation mismatch is based also on the Mincerian wage equation. However, the general educational mismatch specification varies slightly in that the variable of acquired years of schooling is decomposed into three variables – required, surplus and deficit education – following Duncan and Hoffman's (1981) formulation. Overeducation is the number of years of schooling a worker has acquired in excess of the required education needed to perform his job. Undereducation entails the opposite. Under this framework, wages are a function of over, required and deficit years of education (so-called ORU wage equation); that is:

$$W_{ij} = \alpha_j^r S_{ij}^r + \alpha_j^o S_{ij}^o + \alpha_j^u S_{ij}^u + \beta_j X_{ij} + v_{ij} \quad (2)$$

where S^r is years of required education, S^o is years of surplus education above the required level and S^u is years of deficit schooling below the required level.⁹ Then, under this wage equation, the returns from additional education are α_j^r for required years, α_j^o for surplus years and α_j^u for deficit years of education. Notice that instead of imposing the same return in the two sectors, we allow them to differ for workers in each sector j , formal or informal.

Next we want to analyse the returns to education and the effects of occupation–education mismatch on the entire wage distribution for formal and informal workers, by using linear quantile regression estimates. By estimating linear quantile regressions we are able to examine the heterogeneous effect of education at different points in the wage distribution. Moreover, quantile regression estimates are robust to the outliers of the dependent variable and they are also more efficient than the OLS under non-normality of the error terms. For any worker i in sector j we can write the τ th quantile of the hourly wage distribution conditional on actual years of education (S_{ij}) and other characteristics (X_{ij}) as:

$$F_{W_{ij}}^{-1}(\tau|S_{ij}, X_{ij}) = S_{ij}\alpha_j(\tau) + X_{ij}\beta_j(\tau), \forall \tau \in [0, 1] \quad (3)$$

where $F_{W_{ij}}^{-1}(\tau|S_{ij}, X_{ij})$ is the τ th quantile of W_{ij} conditional to S_{ij} and X_{ij} . The estimated quantile regression (QR) coefficients can be interpreted as the rates of return to actual education and other characteristics at different points of the conditional wage distribution. Similarly, for any worker i in sector j we can write the τ th quantile of the hourly wage distribution conditional to years of required education (S_{ij}^r), years of surplus education (S_{ij}^o), years of deficit education (S_{ij}^u), and other characteristics (X_{ij}) as:

$$F_{W_{ij}}^{-1}(\tau|S_{ij}^r, S_{ij}^o, S_{ij}^u, X_{ij}) = S_{ij}^r \alpha_j^r(\tau) + S_{ij}^o \alpha_j^o(\tau) + S_{ij}^u \alpha_j^u(\tau) + X_{ij} \beta_j(\tau), \forall \tau \in [0, 1] \quad (4)$$

The specifications formulated so far (Equations 1–4) neglect the existence of non-observable characteristics that could simultaneously affect wages and the sector in which the individuals are currently working. This will result in obtaining not only biased, but also inconsistent coefficients of the return to education. To account for this concern, we implement the conventional approach of including a selection correction in the wage regressions for each sector. This entails a two-stage estimation process. In a first stage a reduced-form probit model of the formal vs informal decision is estimated, and a sample selection correction term is obtained. In stage two, the correction term is incorporated into conventional Mincerian semi-log earnings functions for the formally and informally employed (see, for example, Gong & van Soest [2002]; Günther & Launov [2012]).

The selection process of the sector of employment follows the latent model:

$$E_i^* = \gamma Z_i + \mu_i \quad (5)$$

where E_i^* is a latent variable that determines the sector j (=formal, informal) in which individual i is employed, Z_i is a vector of observed individual characteristics included in X_i in the wages equations

plus some other variable(s) likely to affect the propensity to be employed in the formal or informal sector, and μ_i is the error term.

The observed binary variable E_i is related to the latent variable E_i^* as follows: $E_i = 1$ if the individual is in the formal sector ($E_i^* \geq 0$); $E_i = 0$ otherwise.

Estimates of returns based on the wage Equations (1) to (4), leaving aside the selection Equation (5), are biased and inconsistent if the error term of the selection equation and the error terms of the wage equations are correlated, for example $\text{cov}[\mu_i, \varepsilon_{ij}] = \rho_j \neq 0$ for the mean Mincerian wage equation in Equation (1).

In the case of estimates at the mean, consistency can be obtained by maximum likelihood considering the information from the selection and wage equations or, alternatively, by applying the two-step method proposed by Heckman (1979). The so-called *Heckit* method includes the inverse Mills ratio in the wage equation as an additional regressor to obtain wages conditional on being in the formal or informal sector.

While the methods for correcting sample selection for mean regression are well acknowledged, there are few known approaches to correct for selectivity bias in quantile regression models and there is little consensus regarding the most appropriate correction procedure. Buchinsky (1998) suggests an approach to approximate the selection term by a power series expansion of the inverse of the Mill's ratio, and is the most common approach used so far for correcting selectivity in quantile regression models (Albrecht, van Vuuren, & Vroman, 2009; de la Rica, Dolado, & Llorens, 2008; Garcia, Hernández, & López-Nicolás, 2001).

More details on estimation issues, including exclusion restrictions in the sample selection specification and the effect of endogeneity of the measures of education, are provided in Section 2 of the Online Appendix.

4. Returns to Education across Sectors – Empirical Results

4.1 OLS Regressions

Table 2 shows the coefficients obtained from estimating the Mincer wage Equation (1) and the ORU wage Equation (2). Estimates were done separately for formal and informal workers. A simple specification for the two wage equations was used to account fully the effect of human capital variables. It includes as explanatory variables the number of years of education (actual years of education in the Mincerian wage equation and years of education decomposed into surplus, required and deficit in the ORU wage equation), the years of experience and its square, the months of tenure with the current firm and its square, and the gender of the individual. The results of this simple specification are presented in the first column of each estimated wage equation.

As it has been shown in the descriptive analysis, formal and informal workers differ significantly in firm and individual characteristics, beside those related to human capital. For instance, given that firms tend to be larger in the formal sector and larger firms pay more, formal workers could obtain a higher return to their education just because they are more prone to work in large firms while informal workers are more likely to work in small firms. Thus, to ensure that the comparison of the returns to education across the two sectors is done for observably similar workers, a more comprehensive specification that includes additional controls was used for the two wage equations. Besides, including additional individual and job characteristics also allows us to disentangle to what extent these observable characteristics explain the average wage differentials across formal and informal workers. These controls include dummy variables for marital status, head of household, occupation, contract signed, size of the firm, industry sector, hours worked and a dummy variable indicating the metropolitan area. The results of this more comprehensive specification are shown in the second set of column of each estimated wage equation in Table 2.

We start by describing the results of the Mincerian wage equation for the simple specification (columns labelled 1). The results show that education is better rewarded in the formal sector than in the informal sector, since each additional year of schooling increases hourly wages by 10.08 per cent for

Table 2. Returns to years of education at the mean; Mincer and ORU models

| | Mincer | | | | ORU | | | |
|------------------------|----------------------|----------------------|----------------------|----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| | [1] | | [2] | | [1] | | [2] | |
| | Formal | Informal | Formal | Informal | Formal | Informal | Formal | Informal |
| Actual | 0.1008** [0.0014] | 0.0543** [0.0023] | 0.0900** [0.0014] | 0.0419** [0.0021] | — | — | — | — |
| Surplus | — | — | — | — | 0.0931** [0.0028] | 0.0416** [0.0052] | 0.0860** [0.0025] | 0.0362** [0.0045] |
| Required | — | — | — | — | 0.1323** [0.0017] | 0.0763** [0.0034] | 0.1206** [0.0016] | 0.0633** [0.0035] |
| Deficit | — | — | — | — | −0.0336** [0.0035] | −0.0468** [0.0044] | −0.0310** [0.0032] | −0.0362** [0.0039] |
| Tests equality effects | | | | | | | | |
| All variables Mincer | F 91.47 | p-value 0.0000 | F 30.24 | p-value 0.0000 | F — | p-value — | F — | p-value — |
| Actual | 318.39 | 0.0000 | 375.65 | 0.0000 | — | — | — | — |
| All variables ORU | — | — | — | — | 54.76 | 0.0000 | 23.81 | 0.0000 |
| All mismatch | — | — | — | — | 93.84 | 0.0000 | 94.96 | 0.0000 |
| Surplus | — | — | — | — | 87.3 | 0.0000 | 100.76 | 0.0000 |
| Required | — | — | — | — | 254.56 | 0.0000 | 249.43 | 0.0000 |
| Deficit | — | — | — | — | 5.94 | 0.0148 | 1.13 | 0.2879 |
| Observations | 9,512 | 4,284 | 9,512 | 4,284 | 9,512 | 4,284 | 9,512 | 4,284 |
| F-statistic | 1,014.1 | 125.5 | 284.26 | 72.61 | 996.3 | 106.1 | 328.2 | 71.2 |
| R squared (adj.) | 0.39 | 0.15 | 0.50 | 0.36 | 0.46 | 0.16 | 0.55 | 0.37 |

Notes: [1] = experience (and its square), tenure (and its square) and gender are included as controls.
[2] = [1] + marital status, head of household, hours worked, type of contract, size of the firm, sector and region are included as controls.
Standard errors in []. ** p < 0.01.

formal workers, which is around double than for informal workers, 5.43 per cent. As expected, once additional controls are accounted for (columns labelled 2) the return to schooling estimated for both sectors decreases. Each additional year of schooling raises hourly wage by 9.00 per cent for formal workers and by 4.19 per cent for informal workers. Nevertheless, the finding that formal workers have a higher return to their education than informal workers still holds. Results of tests of equality of returns at the bottom panel of [Table 2](#) confirm that returns are statistically higher in the formal sector in both specifications.

Considering the existence of educational mismatches gives an interesting picture of the difference in the returns to schooling across the two sectors. [Table 2](#) also presents the returns associated with schooling when educational mismatches are present – the ORU wage Equation (2). Consistent with previous literature, (1) the returns to surplus schooling are lower than the returns to required schooling, (2) a year of deficit schooling carries a wage penalty for both sectors, and (3) the returns on required education are higher than that on actual or attained education in the Mincer equation. As it can be seen, the returns to required and to surplus schooling are higher in the formal than in the informal sector. Results from the specification that does not include the full set of controls indicate that one additional year of required education raises hourly wages by 13.23 per cent in the formal sector and by 7.63 per cent in the informal. Years of surplus education are associated with an earning increase of 9.31 per cent for formal workers and 4.16 per cent for informal workers. The difference in returns is statistically significant in both cases, as revealed by test statistics at the bottom panel of [Table 2](#). Noteworthy is that the penalty of deficit schooling is not very dissimilar across the two sectors, 3.36 per cent for formal workers and 4.68 per cent for informal workers. As for the results when additional controls are included in the estimation of the ORU wage equation, it can be observed that the returns to required and surplus schooling diminish but only slightly, whereas the decrease in the estimate of the penalty of deficit schooling is more intense for informal workers. In any case, regardless of the inclusion or not of additional controls, results of the test statistics at the bottom panel of [Table 2](#) confirm that the returns to required and surplus education for formal workers are significantly higher than those for informal workers, whereas the difference for deficit education is not statistically significant in the specification that includes additional controls.

To sum up, estimates indicate that formal workers have higher returns to their years of education than informal workers, and this is so in the presence of educational mismatch. Moreover, overeducated informal workers are doubly penalised, since in addition to the lower return to years of required education for the fact of being in the informal sector, they face a second penalty associated with the lower returns they obtain because of the discrepancies between workers' actual years of education and the level of education required for performing their job, that is considerably larger than that for their formal counterparts.¹⁰

The gap in the estimated return to schooling between formal and informal workers is wide enough to allow us to conclude that formal workers receive a much higher payoff for required and over-education than do informal workers, even if estimates were somehow contaminated by endogeneity.¹¹ In any case, an alternative interpretation of the results is possible thanks to the distinction between the two sectors. Conditioning to the level of education and the other set of individual characteristics, it could be assumed that the ablest individuals have skills that made them more prone to work in a formal job, whereas individuals endowed with less ability are more abundant in the informal sector (the sorting-by-skills hypothesis). Assuming the standard connection between ability, education and wages, the higher return to years of required and surplus education in the formal sector would result from the payoff to the higher unobservable skills of formal workers with respect to otherwise similar workers in the informal sector. The same argument applies if ability is replaced by the quality of education. In this case, it can be argued that individuals with a superior quality of their education have more chances to be employed in the formal sector while, at the same time, it is reasonable to assume that there is a wage return to the quality of education.¹²

Table 3. Returns to years of education at the quartiles; Mincer and ORU models

| | QR | | | | | | | |
|------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| | Mean | | q25 | | q50 | | q75 | |
| | Formal | Informal | Formal | Informal | Formal | Informal | Formal | Informal |
| Actual | 0.0900** [0.0014] | 0.0419** [0.0021] | 0.0461** [0.0009] | 0.0323** [0.0029] | 0.0771** [0.0017] | 0.0321** [0.0021] | 0.0999** [0.0025] | 0.0339** [0.0018] |
| Surplus | 0.0860** [0.0025] | 0.0362** [0.0045] | 0.0446** [0.0019] | 0.0298** [0.0058] | 0.0710** [0.0026] | 0.0323** [0.0039] | 0.0963** [0.0034] | 0.0306** [0.0036] |
| Required | 0.1206** [0.0016] | 0.0633** [0.0035] | 0.0685** [0.0011] | 0.0473** [0.0044] | 0.1081** [0.0016] | 0.0501** [0.0030] | 0.1375** [0.0023] | 0.0565** [0.0029] |
| Deficit | -0.0310** [0.0032] | -0.0362** [0.0039] | -0.0232** [0.0025] | -0.0307** [0.0051] | -0.0223** [0.0032] | -0.0261** [0.0033] | -0.0188** [0.0039] | -0.0281** [0.0031] |
| Tests equality effects | F | p-value | F | p-value | F | p-value | F | p-value |
| All variables Mincer | 30.24 | 0.0000 | 21.8 | 0.0000 | 18.81 | 0.0000 | 17.43 | 0.0000 |
| Actual | 375.65 | 0.0000 | 23.79 | 0.0000 | 229.92 | 0.0000 | 353.74 | 0.0000 |
| All variables ORU | 23.81 | 0.0000 | 22.05 | 0.0000 | 18.66 | 0.0000 | 16.79 | 0.0000 |
| All mismatch | 94.96 | 0.0000 | 9.86 | 0.0000 | 73.48 | 0.0000 | 114.5 | 0.0000 |
| Surplus | 100.76 | 0.0000 | 6.84 | 0.0000 | 50.02 | 0.0000 | 108.94 | 0.0000 |
| Required | 249.43 | 0.0000 | 26.3 | 0.0000 | 209.89 | 0.0000 | 309.31 | 0.0000 |
| Deficit | 1.13 | 0.2879 | 1.8 | 0.18 | 0.49 | 0.4818 | 2.23 | 0.1353 |
| Observations | 9,512 | 4,284 | 9,512 | 4,284 | 9,512 | 4,284 | 9,512 | 4,284 |

Notes: Experience (and its square), tenure (and its square), gender, marital status, head of household, hours worked, type of contract, size of the firm, sector and region are included as controls in all regressions. Standard errors in []. ** p < 0.01.

4.2 Quantile Regressions

The OLS results provide the return estimates at the mean of the wage distribution, which may be hiding important differences in the return estimates at different points of the wage distribution. [Table 3](#) presents the (conditional) quantile regressions results obtained from estimating the Mincerian wage equation – Equation (3) – in the upper panel and the ORU wage equation – Equation (4) – in the lower panel. Results of tests of the hypothesis of equality of returns in each specification, and quantile are also included below the estimate of the parameters. Both equations were estimated using the set of all available controls (dummy variables for marital status, head of household, occupation, contract signed, size of the firm, sector industry, hours worked and metropolitan area).¹³ It is worth noting that the estimated effects in [Table 3](#) correspond to those observed at different points of the distribution of wages conditional to these observable controls. In other words, they correspond to the effects along the distribution of the wage levels determined by unobservable characteristics such as the individual's ability and quality of education. To facilitate the comparison of results at the different quantiles with those at the average, results of the OLS estimates are reproduced in the first group of columns in [Table 3](#).

The results reveal that schooling is not uniformly rewarded in the labour market along the conditional wage distribution. More specifically, the return to actual education (upper panel of [Table 3](#)) increases along the wage distribution for formal workers, while a comparable pattern is not observable for informal workers. Results for formal workers are thus consistent with the payoff of investments in education increasing with ability and quality of education. The less able formal workers and/or those with the inferior quality of education are likely to earn the lowest wages conditional to the observed characteristics (including acquired education), whereas the opposite is assumed to be the case for the ablest workers and/or those with the best quality of education. Results of the quantile regression indicate that the return to schooling is lower for formal workers at the lower end of the conditional wage distribution, and thus for those less able and/or whose education is of lower quality. On the contrary, the higher return for workers with high conditional wages suggests that it is higher for the ablest formal workers and/or those whose education is of superior quality. In contrast, the quantile regression estimates of the Mincerian wage equation in [Table 3](#) suggest that the unobservable characteristics do not affect the return to schooling of workers in the informal sector. If conditional wages are determined by ability and quality of education also for informal workers, the similarity of the estimated returns to schooling at different points of the distribution indicates that they are not affected by these unobservable characteristics.

Interestingly, the difference in the return to actual education for formal and informal workers in the first quartile is moderate (4.61% versus 3.23%) although statistically significant, while at the third quartile the return to actual education for formal workers is around three times higher than that for informal workers (9.99% versus 3.39%). That the returns to education for formal workers at the lower quartile are not far above those of informal workers counterparts can be the result of the existence of a minimum wage, binding only for the formal sector, which could be imposing an important distortion to the returns to education to formal sector workers at this part of the distribution. Alternatively, it might be that the endowment of ability (and/or the quality of education) was similar for formal workers at the lower end of the conditional wage distribution and for the entire group of informal workers. This would explain the similarity in the return to acquired education between the lower part of the distribution of formal workers and the entire distribution for informal workers. Similarly, the higher return for formal workers at upper quantiles could be explained by the fact that skilful workers (because their endowment of ability and/or the quality of their education are higher) are more abundant in that sector than in the informal sector.

As for the estimation of the ORU specification in Equation 4 at the different quartiles (bottom panel of [Table 3](#)), results show that the behaviour of the returns to required education resembles that of actual education: they increase substantially along the wage distribution for formal workers, but only experience a moderate change for informal workers. Remarkably, results also suggest that the returns to surplus education behave similarly, increasing along the wage distribution for formal workers and remaining almost constant across the different quantiles for informal workers. In turn, the pattern of the penalty

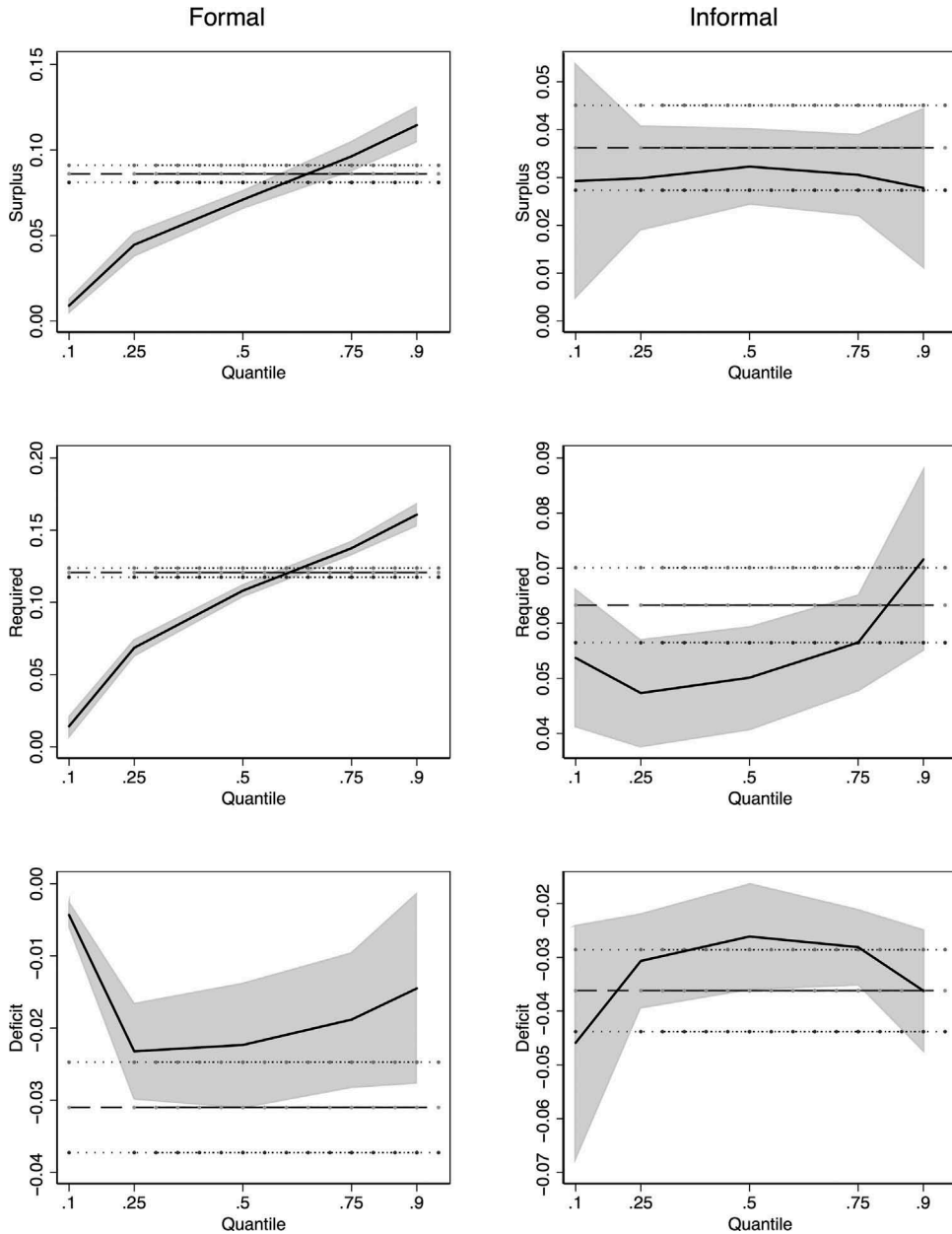


Figure 1. Returns to surplus-required-deficit years of education over the entire distribution.

associated to deficit education is different for formal and informal workers, although the order of magnitude of the difference in this case is much lower than for required and surplus education. A clearer picture of these patterns is obtained by plotting the estimated returns at each percentile for formal and informal workers as in [Figure 1](#). As can be seen, returns to education are not homogenous along the wage distribution, and this heterogeneous behaviour is very different for formal and informal workers.

A more detailed inspection of the lower panel of [Table 3](#) reveals additional key information. For instance, differences in the educational returns between formal and informal workers with the same educational–occupational mismatching are present at the first quartile, although less sizeable than the differences presented in the third quartile. Results of the test statistics at the different quartiles confirm what is derived from the simple comparison of the differences in the estimated returns between the two

groups of workers, as values of the tests are lower at the bottom end of the distribution for surplus and required education. Formal workers that possess the education required to do their jobs have a higher return to their education, slightly higher in the lowest quartile and more than double in the upper. An overeducated formal worker in the lower part of the distribution obtain a return of his years of surplus education similar to the return obtained by an informal worker for the years of education required to perform his job, 4.46 per cent and 4.73 per cent respectively. Meanwhile the returns to surplus education for formal workers at the third quartile of the distribution are larger than the returns to required education for informal workers, 9.63 per cent and 5.65 per cent correspondingly. Finally, as in the case of the results in the mean, the hypothesis of equality for the coefficients of deficit years of schooling is not rejected in all quartiles, which confirms that there is not a significant formal–informal gap in the return to deficit schooling in any part of the distribution.

Summing up, the results from the conditional quantile regression suggest that formal workers are able to obtain a higher reward for their education even in the presence of educational mismatch, and this is so all along the wage distribution. Furthermore, the returns to surplus education increase considerably for formal workers along the wage distribution, suggesting that this type of jobs represents better employment opportunities for overeducated workers. This probably reflects the fact that formal workers may take advantage of the higher productivity¹⁴ of these jobs, which coupled with their higher unobserved skills may boost the returns to education. Meanwhile, informal workers receive a lower remuneration to their education compared to the one obtained by their formal peers. This difference in returns to education between formal and informal workers is even more accentuated in the upper part of the distribution. More importantly, informal overeducated workers do not face higher returns once they move up the wage distribution, implying that informal jobs may constraint the use of education and its returns.

As in the case of the estimated return to acquired education, differences in some unobservable characteristics between workers in the formal and the informal sector might help to interpret the gap in the return to required, surplus and deficit education. If ability and quality of the acquired education contribute to segregate workers in the formal and informal sectors, it is reasonable to observe a higher return to required and surplus education, and a lower penalty for undereducation, for formal workers. This is so because the estimate of the return to the components of education would be capturing the effect of the higher skills of workers in the formal sector. It would also explain the increase in the gap when we move up in the conditional wage distribution.

Table 4. Returns to years of education at the mean; Mincer and ORU models correcting for selection

| | Mincer | | | | ORU | | | |
|--------------|----------------------|----------------------|----------------------|----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| | Without | | With selection | | Without | | With selection | |
| | Formal | Informal | Formal | Informal | Formal | Informal | Formal | Informal |
| Actual | 0.0900** [0.0014] | 0.0419** [0.0021] | 0.0907** [0.0017] | 0.0413** [0.0027] | – | – | – | – |
| Surplus | – | – | – | – | 0.0860** [0.0025] | 0.0362** [0.0045] | 0.0852** [0.0027] | 0.0367** [0.0048] |
| Required | – | – | – | – | 0.1206** [0.0016] | 0.0633** [0.0035] | 0.1205** [0.0017] | 0.0632** [0.0038] |
| Deficit | – | – | – | – | –0.0310** [0.0032] | –0.0362** [0.0039] | –0.0337** [0.0033] | –0.0359** [0.0042] |
| Mills ratio | – | – | 0.2458** [0.0462] | 0.0082 [0.0598] | – | – | 0.1827** [0.0446] | –0.0200 [0.0572] |
| Observations | 9,512 | 4,284 | 12,981 | 13,078 | 9,512 | 4,284 | 12,981 | 13,078 |

Notes: Experience (and its square), tenure (and its square), gender, marital status, head of household, hours worked, type of contract, size of the firm, sector and region are included as controls in all regressions.

Standard errors in []. ** p < 0.01.

4.3 Sample Selection

Our estimates of the wage equations, when taking into account that unobservable characteristics might influence both wages and the choice of formal/informal employment, are summarised in Table 4 for the estimates at the mean. These results correspond to estimates of the wage equations augmented by a selection correction term for each sector, using the presence of children in the household and the average number of years of schooling of other household members as instruments for assignment into the formal or informal sector. The reason for choosing these selection variables is motivated by the fact that they should contain household-specific characteristics that influence an individual's propensity towards formal or informal employment, but at the same time have no direct impact on the earning potentials of individuals (Marcouiller, Ruiz de Castilla, & Woodruff [1997]; Günther & Launov [2012] use similar variables as exclusions restrictions).¹⁵ As it can be seen, returns to schooling remain higher for formal workers in the two wage equations (Mincer and ORU) in the specification that includes the mechanism of classification into the formal and informal sectors. It is important to note that the selection term (*Mills ratio*) is positive and statistically significant only for formal workers (Tannuri-Pianto, Pianto, & Arias [2004] find a similar result for Bolivia). This result can be interpreted as evidence of self-selection for workers in the formal sector, and confirm that unobserved characteristics, such as ability and quality of education, favour their employment in a formal job, while affecting positively the wages they earn. In contrast, the selection term is not significantly different from zero in the case of informal workers. This implies that there is no correlation between the error terms of the selection Equation (5) and that of the wage equation for informal workers, and thus that the estimates given in Table 2 for informal workers are indeed unbiased. We also re-estimate the quantile regressions of Equation (3) and Equation (4), introducing the inverse of the Mills's ratio and its square, following the Buchinsky (1998) procedure for correcting for selection bias in quantile regressions. The results are presented in Table 5. It can be observed that the pattern of estimated returns and differences

Table 5. Returns to years of education at the quartiles; Mincer and ORU models correcting for selection

| | QR | | | | | | | |
|---------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| | Mean | | q25 | | q50 | | q75 | |
| | Formal | Informal | Formal | Informal | Formal | Informal | Formal | Informal |
| Actual | 0.0907** [0.0017] | 0.0413** [0.0027] | 0.0489** [0.0008] | 0.0367** [0.0037] | 0.0802** [0.0016] | 0.0373** [0.0020] | 0.1057** [0.0029] | 0.0332** [0.0029] |
| Mills ratio 1 | 0.2458** [0.0462] | 0.0082 [0.0598] | 0.6495** [0.0525] | -0.4065* [0.1777] | 0.7126** [0.0892] | -0.3671** [0.0970] | 0.7524** [0.1456] | -0.1255 [0.1423] |
| Mills ratio 2 | — | — | -0.1419** [0.0177] | 0.0454 [0.0359] | -0.1122** [0.0310] | 0.0495* [0.0206] | -0.1109* [0.0515] | 0.0503 [0.0309] |
| Surplus | 0.0852** [0.0027] | 0.0367** [0.0048] | 0.0488** [0.0019] | 0.0363** [0.0069] | 0.0587** [0.0031] | 0.0398** [0.0039] | 0.0987** [0.0036] | 0.0320** [0.0040] |
| Required | 0.1205** [0.0017] | 0.0632** [0.0038] | 0.0720** [0.0011] | 0.0516** [0.0055] | 0.0969** [0.0017] | 0.0557** [0.0031] | 0.1433** [0.0025] | 0.0590** [0.0034] |
| Deficit | -0.0337** [0.0033] | -0.0359** [0.0042] | -0.0277** [0.0024] | -0.0337** [0.0062] | 0.0049 [0.0037] | -0.0312** [0.0034] | -0.0279** [0.0041] | -0.0281** [0.0035] |
| Mills ratio 1 | 0.1827** [0.0446] | -0.0200 [0.0572] | 0.6735** [0.0600] | -0.4087* [0.1919] | -0.5327** [0.0421] | -0.4296** [0.1089] | 0.8644** [0.1100] | -0.1977+ [0.1137] |
| Mills ratio 2 | — | — | -0.1491** [0.0203] | 0.0501 [0.0386] | 0.2798** [0.0253] | 0.0618** [0.0230] | -0.2020** [0.0391] | 0.0602* [0.0247] |
| Observations | 8,955 | 3,997 | 8,955 | 3,997 | 8,955 | 3,997 | 8,955 | 3,997 |

Notes: Experience (and its square), tenure (and its square), gender, marital status, head of household, hours worked, type of contract, size of the firm, sector and region are included as controls in all regressions. Standard errors in []. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$. Mills ratio 1 and 2 refer to the (inverse of the) first two powers of the ratio.

between formal and informal workers reported and discussed in the previous section do not vary significantly when selection is accounted for.

The estimates presented so far in this section are consistent as long as the variables used to define the exclusion restrictions are correlated with the probability of working in the formal or informal sector but not with the error term of the wage equation. As we already mentioned, it is not possible to implement a formal statistical procedure for testing the validity of the exclusion restrictions. However, in order to obtain some insights on their suitability, the procedure suggested by Cohen-Zada and Elder (2009), and also used in Kim (2011), is implemented. Results of this exercise are discussed in [Section 3](#) of the Online Appendix (see Table A2). They confirm that the exclusion constraints used in our analysis are appropriate and that the main conclusion is robust to alternative sets of exclusion constraints.

All in all, from the results in this section we can assert that the conclusion on the higher penalty associated to educational mismatch for informal workers remains when controlling for the correlation between the error terms in the selection and the wage equations caused by unobserved characteristics.

5. Conclusions

There is now substantial body of literature addressing the wage gap between formal and informal workers for developing countries, theoretically and empirically. In empirical analyses wage equations are estimated for each group of workers, where one of the key factors is education (and its returns). There are studies that have gone beyond the difference in the mean, finding that the wage gap is not stable along the wage distribution, estimating quantile regressions. Some works have questioned the existence of a wage gap (that is, market segmentation) given the endogeneity caused by unobservable characteristics of the individuals, such as ability and quality of education that provoke differences in skills for workers with the same level of education. As far as we know there is no study that considered the fact that education–occupation mismatching is present in both formal and informal sector, and that this may be driving, at least in part, the formal–informal wage gap. In this article we have re-examined the wage gap between formal and informal workers, taking into consideration that education–occupation mismatch is present in both sectors, using the case study of Colombia.

Results for Colombia show that formal workers have a higher return to their education, around double, compared with their informal counterparts. They also indicate that these returns vary along the wage distribution and that the pattern of variation along the distribution is not the same for formal and informal workers. But on the top of that, the main claim in this article is that important information to the analysis of the formal–informal wage gap is obtained by adding measures of educational mismatch. In particular, we showed that the returns to required education in the informal sector are not only lower, but the penalty that informal workers face due to educational mismatches in terms of wages are considerable higher than the one faced by their formal counterparts. Therefore, our results are consistent with the existence of a second penalty associated with educational mismatches that puts informal workers at a greater disadvantage when compared to formal workers.

If labour market segmentation is what is driving the existence of overeducation in a developing country, as Herrera-Idárraga et al. (2012) claim may be the case, then policies engaged with reducing informality could also have other positive effects apart from those commonly known, better-quality jobs. Reducing informality may reduce the situation where a highly schooled worker takes a job with low-skill requirements and consequently low pay. This evidence should be taken into consideration when assessing the issue of informality in the labour market of developing countries, since it is likely to affect the allocation of skilled and unskilled workers in formal and informal jobs, and the incentives to accumulate education. However, we must acknowledge that the results in this article are also compatible with the sorting-by-skills hypothesis, as the higher returns to required and overeducation in the formal sector may well be the result of the higher unobserved skills of workers in this sector. The evidence in this article can be read as these skills favour the

access to a formal job, while allowing workers in the formal sector to obtain a higher payoff for their investments in education with respect to the less-skilled workers in the informal sector of emerging and developing economies.

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Disclosure statement

No potential conflict of interest was reported by the authors.

Notes

1. Duncan and Hoffman (1981), Verdugo and Verdugo (1989), Sicherman (1991), Tsang, Rumberger, and Levin (1991), McGoldrick and Robst (1996) studied the phenomenon for the United States; Alpin, Shackleton, and Walsh (1998), Green, McIntosh, and Vignoles (2002), Dolton and Vignoles (2000) and Chevalier (2003) for the UK; Hartog and Oosterbeek (1988) and Groot and van den Brink (2000) for Holland; Bauer (2002) and Büchel and van Ham (2003) for Germany; Kiker, Santos, and Mendes de Oliveira (1997) and Mendes de Oliveira, Santos, and Kiker (2000) for Portugal; Alba-Ramírez (1993) for Spain. For an extensive review of overeducation in developed countries, see McGuinness (2006), and for a recent survey on overeducation, see Leuven and Oosterbeek (2011).
2. Quinn and Rubb (2006) study the phenomenon for Mexico; Abbas (2008) for Pakistan; Mehta, Felipe, Quising, and Camingue (2011) for India, Mexico, the Philippines and Thailand; Mora (2005), Castillo (2007); and Herrera-Idárraga et al. (2012) for Colombia.
3. See, for example, Magnac (1991), Nuñez (2002), Flórez (2002), Maloney and Nuñez (2004), Kugler and Kugler (2009) and Mondragón-Vélez, Peña, and Willis (2010) for Colombia; Gindling (1991) for Costa Rica; Pradhan and van Soest (1995) for Bolivia; Amuedo-Dorantes (2004) for Chile; Pratap and Quintin (2006) for Argentina; Tansel (2000) for Turkey; Marcouiller et al. (1997) and Gong and van Soest (2002) for Mexico; Botelho and Ponczek (2011) for Brazil; Badaoui, Strobl, and Walsh (2008) for South Africa.
4. We thank an anonymous referee for raising the issue of endogeneity in the context of the ORU equation. We must also acknowledge the existence of another potential source of bias when estimating the ORU wage equation due to measurement error in required, surplus and deficit education (see Leuven & Oosterbeek [2011] for details). As in the case of unobservable characteristics, the previous literature has not addressed satisfactorily this issue, which is closely related to the way in which educational mismatch is measured in empirical studies.
5. The definition of the Seventeenth International Conferences of Labour Statisticians of informal employment is 'based on the characteristics of the individual's employment, job or position. A worker has an informal job if the employment relationship is, in law or in practice, not subject to national labour or social legislation. This condition of informal employment is observed in persons employed in both formal and informal enterprises, as well as in those employed in domestic service by households' (ILO, 2011, p. 64).
6. For purpose of brevity we only include in the article the results obtained with the mean, as with the mode the results are not significantly different. The full set of results is available on request.
7. The monthly minimum wage in Colombia in 2010 was 515,000 pesos, equivalent to 2,503.47 pesos per hour (this value is obtained by first dividing the monthly minimum wage by 4.3 to obtain weekly wage which in turn is divided by 48 weekly hours of work to reach hourly wage).
8. A close inspection of the data shows that on average undereducated workers at the lower part of the distribution earn a wage equal to the minimum monthly wage; however, as some undereducated workers reported working more than 48 hours, the wage observed at the lower quartile is slightly less than the computed minimum hourly wage.
9. Years of acquired education equals years of required education plus years of surplus education minus years of deficit education ($S = S^+ + S^0 - S^-$).
10. Similar results are obtained when the required years of education for each occupation are computed using the samples of formal and informal workers separately, as well as when using that of formal workers for both groups. These results are available from the authors upon request.

11. It can also be argued that if estimates were affected by endogeneity, unobservables would be biasing estimates of returns for formal and informal workers in the same direction and with a similar relative magnitude. In such a case, the gap between the two sectors would remain substantial.
12. Unfortunately, information about the quality of education is not available in the CHS. Neither is it possible to merge data from this survey with any other containing information on proxies for quality of the acquired education in Colombia. As an indirect check of the relationship between the sector of employment and the quality of education, we compared the average scores of the ICFER SABER grade 11 in the Colombian cities with their share of informal employment. Results did not suggest any significant relationship between the two magnitudes (the correlation coefficient is as low as 0.26, and cities with high incidence of informality do not necessarily show the lowest scores in the ICFER tests). We thank an anonymous referee for suggesting this type of comparison.
13. Similar results were obtained with the simple specification that does not include the additional set of controls. They are available from the authors.
14. The productivity of formal firms could be higher than that of informal firms because a higher capital–labour ratio caused by the fact that informal firms may have less access to credit (Amaral & Quintin, 2006). Another reason is that informal firms continue to operate at a small size that allows them to escape government control and, therefore, cannot exploit possible economies of scale.
15. As mentioned in Section 3, consistency of the estimates in this section relies on the appropriateness of the exclusion restrictions; that is to say, on these variables not determining the wage level in a direct way. As far as we are aware, it is not possible to test for the fulfilment of these restrictions.

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