# Sheepskin Effects in the Returns to Education by Ethnic Group: Evidence from Northeastern Brazil*

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**Abstract**

The purpose of this paper is to examine inter-ethnic differences in the returns to education for the three main ethnic groups in the Metropolitan Region of Salvador (MRS), Bahia state, in Northeastern Brazil. Our results suggest that sheepskin effects take the traditional form of an additional return to the completion of a diploma for whites, whereas for blacks the additional return stems entirely from the sheepskin-like effect associated with admission to university. We show that it is possible to explain the observed pattern of inter-ethnic differences in the returns to education using a model of statistical discrimination that builds on the work of S. Lundberg and R. Startz and incorporates differences in the cost of acquiring an education that are usually associated with signaling models.

Keywords: Statistical Discrimination, Earnings, Brazil

JEL Classification: J71, J31

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# 1 Introduction

In recent years, it has become increasingly apparent in many contexts that, in addition to the conventional returns to education that flow from a standard Mincerian wage equation, there are additional returns that stem from the signals furnished by diplomas.[1] Such "sheepskin" effects, and any inter-ethnic differences in these effects that may obtain, have been justified on the basis of at least two approaches. On the one hand, the theory of statistical discrimination, as initially proposed by Phelps (1977) and subsequently developed by Aigner and Cain (1977), Lundberg and Startz (1983), as well as by Oettinger (1996), assumes that the signal furnished by a given level of education is less precise for the minority group (because exams may favor the majority group). In such a case, for an individual of a given skill, income will be greater for the minority group at low levels of education, whereas the opposite will be true at higher levels of education. On the other hand, authors such as Golbe (1985) or Belman and Heywood (1991) interpret "sheepskin" effects in terms of a simple signaling model in the tradition of Spence (1973). By assuming that the cost of a high level signal (college education, for example) is greater for the minority group, it follows that members of the minority who choose to pursue their studies will benefit from a higher level of remuneration than the majority group. If the implications of these two approaches in terms of the inter-ethnic pattern of sheepskin effects that one should observe are opposite, in both cases imperfect information leads to inter-ethnic differences in the returns to schooling.[2] In addition, under certain conditions, imperfect information may result in group discrimination, to whit, different average earnings by ethnic group.[3]

The purpose of this paper is to examine inter-ethnic differences in the returns to education for the three main ethnic groups in the Metropolitan Region of Salvador (MRS), Bahia state, in Northeastern Brazil, and to ascertain whether their pattern is consistent with a simple model based on asymmetric information. In particular, we show that it is possible to explain the observed pattern of inter-ethnic differences in the returns to education in Northeastern Brazil with a model of statistical discrimination that builds on the work of Lundberg and Startz (1983) and incorporates differences in the cost of acquiring an education that is usually associated with a signaling model.

In addition to traditional sheepskin effects associated with the completion of primary, secondary or university education, we focus on the potential signal furnished by admission to university, which is likely to be a very powerful indicator available to employers because of the selectivity of the university entrance exam in the state of Bahia, known as the

[1] See Hungerford and Solon (1987), Belman and Heywood (1991), Jaeger and Page (1996), Patrinos (1996), Park (1999) and Arke (1999).

[2] An excellent survey of this literature is provided by Glen Cain (1986).

[3] On the conditions under which group discrimination obtains, see particularly Lundenberg and Startz (1983) and Oettinger (1996).

"vestibular" in Portuguese.[4] The contrast between the accuracy of the signal furnished by "conventional" educational attainment, which is widely perceived as being lower for Blacks than for Whites for all years of schooling except for university admission, and the contrasting, but widely-held, perception that university admission is a more accurate signal of true productivity for Blacks than for Whites, constitutes the analytical crux of our paper.

The main empirical results of this paper are as follows. First, admission to university yields a return of 141 percent for Blacks whereas the corresponding figures for Whites and individuals of mixed race are 51.81 and 74.40 percent, respectively. Second, having completed primary, secondary or a four year university degree yields a greater rate of return for Whites than for Blacks. As we show in the paper, this pattern of inter-ethnic differences in the returns to these levels of educational attainment are consistent with a theoretical model that focuses on inter-ethnic differences in the perceived accuracy of different educational signals.

There are at least three reasons that suggest a broader interest of our results, outside the simple estimation of Mincerian wage equations. First, while non-linearities in the returns to education have been suggested in the Brazilian context, especially in work by Lam and Schoeni (1993), and by Strauss and Thomas (1996), there has been no attempt, to the best of our knowledge, to consider inter-ethnic differences in sheepskin effects. This is surprising given that, in terms of resource allocation geared toward reducing income inequality, it is extremely important to be able to identify any inter-ethnic differences in educational returns, which in turn feed into broader measures of inequality.

Second, and though this has long been brushed under the rug by appeals to the theory of racial democracy initially proposed in the celebrated work of Freyre, racial discrimination is today a topic of hot debate in Brazil, at least in the social sciences outside of economics.[5] Most observers agree that there is a "color hierarchy" in Brazil and that, the darker one's skin tone, the greater the barriers in the way of social advancement. However, surprisingly little attention has been devoted to the question in the economics literature.[6] Our paper therefore throws a bridge between the economics literature and the results from other disciplines, and largely corroborates the widespread feeling that there is discrimination in the Brazilian labor market, which stems from persistent racial prejudice.[7]

Third, our results lead one to the question of how such racial inequalities can be effectively combated. In particular, if discrimination is the fruit of racial prejudice, policies

[4] The *vestibular*, as in vestibule or entrance in English, is a university entrance exam that was created in 1910.

[5] For a discussion of racial discrimination, see Hasenbalg and do Valle Silva, (1992), Skidmore (1992) and Jaccoud and Beghin (2002).

[6] See Soares (2000) and Henriques (2001).

[7] See Santos (2001).

aimed at heightening the feelings of self-worth of groups that suffer from discrimination are likely to be more effective than affirmative action campaigns or measures of a more repressive nature.[8]

# 2 A simple asymmetric information model of the labor market in the Brazilian Nordeste

## 2.1 Two stylized facts and a simple model

The pattern of discrimination that obtains in the Brazilian Nordeste suggests that a model yielding statistical discrimination would be the most appropriate, although Brazilian particularities, such as inter-ethnic differences in the relative costs of and benefits to a given level of education must also be taken into account.

Two important stylized facts stand out concerning the Brazilian educational system in general, and the educational system of the MRS in particular. First, school quality, especially for Blacks, is generally believed to be extremely heterogeneous, and is perceived by employers as furnishing a relatively inaccurate signal concerning an individual's true productivity. Second, and in contrast to the formal schooling system, the *vestibular* university entrance examination is widely regarded as being extremely selective and is seen by most employers as being a very accurate measure of an individual's ability. This is particularly true for Blacks, who constitute a tiny minority of university students, especially at the more selective public universities. In 2001, Afro-Brazilians occupied 42.6% of the seats at Bahia State University (UFBA, public university), whereas they represented 74.95% of the population in the State of Bahia.

In order to be able to take employer perceptions, as well as individual educational investment decisions, into account simultaneously, we consider a simple model in the tradition of Lundberg and Startz (1983), which we shall modify in order to account for Brazilian specificities. Let $\theta$ be the marginal productivity of a worker, $a$ her innate ability, and $h$ her level of ability acquired through education. We pose $\theta = a + bh$, where $b$ is a parameter. The cost of acquiring ability through education is given by $c\frac{h^2}{2}$, where $c$ is a parameter. The employer observes neither the marginal productivity $\theta$ of the employee, nor her level of acquired ability $h$. Rather, she observes a signal $\lambda$, usually understood to be the number of years of completed schooling, which is assumed to be correlated with the marginal productivity of the worker. This is posed as:

$$\lambda = \theta + \varepsilon, \tag{1}$$

[8] See Jaccoud and Beghin (2002) and Bernardino (2002).

where $(a, \varepsilon)$ are assumed to be random variables distributed according to the bivariate normal density function. For simplicity, it will be assumed that the correlation between $a$ and $\varepsilon$ is zero, although this does not affect the qualitative flavor of the ensuing results. Formally speaking, the assumption on the joint distribution of $a$ and $\varepsilon$ may be written as:

$$(a, \varepsilon) \sim N(\mu_a, \mu_\varepsilon, \sigma_a^2, \sigma_\varepsilon^2, 0). \tag{2}$$

In what follows, we shall refer to $\varepsilon$ as the "noise" in the signal. The standard solution approach used in such models involves the undetermined coefficients method (used traditionally in the rational expectations literature), and allows one to solve for the firm's optimal wage-offer curve as:[9]

$$w = \left(1 - \rho^2\right) \lambda + \rho^2 \mu_\lambda, \tag{3}$$

where

$$\rho = \sqrt{\frac{\sigma_a^2}{\sigma_a^2 + \sigma_\varepsilon^2}} \tag{4}$$

Intuitively, the perception of the accuracy of the signal furnished by a given level of educational attainment $\lambda$ is inversely related to $\rho$. In terms of individual educational investment, the model also allows one to solve for the worker's optimal level of ability acquired through education as:

$$h^* = \left(1 - \rho^2\right) \frac{b}{c}, \tag{5}$$

whereas the equilibrium marginal productivity of a worker is given by:

$$\theta^* = a + \frac{b^2}{c} \left(1 - \rho^2\right). \tag{6}$$

The implications of this model as set out in equations (3) and (5) are clear. Equation (3) shows that the expected salary will be a weighted average of the signal furnished by the potential employee ($\lambda$) and the average productivity of the underlying population ($\mu_\lambda$). The weight associated with the signal is an increasing function of the latter's precision; that is, the smaller $\rho^2$, the greater the weight given to the signal. Equation (5) shows that $h^*$ will be an increasing function of the precision of the signal, although it will also depend upon the relative costs and benefits to investment in education ($b/c$).

To what extent can such a model be used to explain the group-level discrimination that would appear to be such a pervasive feature of the Brazilian labor market, while assuming that the distribution of innate ability $a$ is the same in each ethnic group? More importantly, does such a model allow one to formulate testable hypotheses that would flow from the two stylized facts mentioned above?

[9] The formal derivation of the model is relegated to the Appendix.

Equations (3) and (5) show that there are three parameters, $b$, $c$ and $\rho^2$ (and which are likely to be specific to each ethnic group), that can affect the average level of remuneration of a given ethnic group as well as the returns to a given level of the educational signal. Consider two ethnic groups, White and Black. The model presented above implies that the two wage offer curves are given by:

$$w_b = \left(1 - \rho_b^2\right)\lambda + \rho_b^2 \mu_{\lambda_b} \text{ and } w_w = \left(1 - \rho_w^2\right)\lambda + \rho_w^2 \mu_{\lambda_w}. \tag{7}$$

From (7), it is clear that the slopes of the wage offer curves will depend solely on the subjective assessment of a worker's productivity, which in turn is a function of the perceived accuracy of the signal furnished by a given level of educational attainment ($1 - \rho_w^2$ and $1 - \rho_b^2$). In contrast, the intercepts will be functions not only of the accuracy of the signals, but of the average levels of educational attainment of the corresponding populations as well ($\mu_{\lambda_w}$ and $\mu_{\lambda_b}$).

## 2.2 Implications for conventional schooling

Recall that our first stylized fact concerning employer perceptions of the Brazilian educational system was that the accuracy of the signal furnished by a given level of educational attainment (with the exception of university admission) is lower for blacks than for whites. This should not be surprising in that Brazil is characterized by the coexistence at all levels of education of private and public institutions of learning, with a great level of decentralization at the primary level. This leads to the quality, especially of primary education, being largely a function of municipal income levels, which vary enormously even within a relatively limited geographical area such as the MRS. In terms of our model, this means that the variance of the noise associated with the signal is greater for Blacks than for Whites:

$$\sigma_{\varepsilon b}^2 > \sigma_{\varepsilon w}^2.$$

This inequality corresponds to the hypothesis, associated with the work of Arrow (1973), Aigner and Cain (1977) or Lundberg and Startz (1983), that the signal furnished by a given level of schooling is less reliable for Blacks than for Whites since, by equation (4) and under the hypothesis that both ethnic groups display the same variance in intrinsic ability ($\sigma_{ab}^2 = \sigma_{aw}^2 = \sigma_a^2$):

$$1 - \rho_w^2 = 1 - \frac{\sigma_a^2}{\sigma_a^2 + \sigma_{\varepsilon w}^2} > 1 - \frac{\sigma_a^2}{\sigma_a^2 + \sigma_{\varepsilon b}^2} = 1 - \rho_b^2. \tag{8}$$

The marginal returns to a given level of education, as assessed by a wage regression, should therefore be larger for Whites than for Blacks. A second point concerns the relative costs and benefits of education, and should not be confused with the *accuracy* of the educational signal. Though private schools are available for the better-off, these are often inaccessible to Afrobrazilians for lack of means. In other words, for given $b$, $c$ is higher on average for the Afro-Brazilian population. Moreover, Blacks usually reside in poorer neighborhoods and the average quality of their schooling, because of the decentralized nature of public education, it therefore likely to be lower than that of Whites. For given $c$, $b$ will be lesser for the Afro-Brazilian population.[10] This means that it is likely that the ratio $b/c$ is specific to each ethnic group, with Blacks facing a lower $b/c$ ratio than Whites.

Formally speaking, this implies, by equation (5), that the level of educational investment by Blacks will be lower than for Whites. As long as the difference in the accuracy of the educational signal between the two ethnic groups does not overwhelm the difference in the benefit-cost ratio, the implication will be that the intercept in the wage offer curve will be smaller for Blacks than for Whites.[11]

### 2.3 Implications for university admission

Consider now the signal furnished by admission to university, which depends upon successful performance in the *vestibular* entrance examination. Our second stylized fact was that the signal furnished to employers by successful admission to university is generally perceived as being more accurate for Blacks than for Whites. As mentioned earlier, the *vestibular* is widely seen as being highly selective. In general, only wealthier students coming from better private schools and expensive *vestibular* preparatory programs are able to successfully pass it.[12] Contrary to the examinations associated with the completion of primary and secondary school, the *vestibular* is not specific to the type of school attended by the student. Indeed, while the difficulty of the exams corresponding to completion of primary and secondary school depends on the quality and selectivity of each school, the difficulty of admission to university depends on the type of university one wishes to attend. It is therefore not surprising that employers in the MRS consider the *vestibular* to be a highly accurate measure of the potential productivity of employees, and that they view this signal as being more accurate for Blacks than for Whites. It is interesting to note that this point corresponds to the argument advanced by Borjas and Goldberg (1983), Golbe (1985) and Belman and Heywood (1991) that the cost of an inaccurate signal is so high that poor students are perceived as having a higher probability than rich students of furnishing an accurate signal, through their admission to university.

[10] See Behrman, Birdsall and Kaplan (1996), Birdsall and Sabot (1996).

[11] Formally speaking, the condition for the intercept of the black wage offer curve to be smaller than that of the white wage offer curve is given by

$$\rho_b^2 \left[ a + \frac{b_b^2}{c} \left(1 - \rho_b^2\right) \right] < \rho_w^2 \left[ a + \frac{b_w^2}{c} \left(1 - \rho_w^2\right) \right].$$

[12] See Jaccoud and Beghin (2002), Plank, Sobrinho and Antonio Carlos da Ressurreiçao Xavier (1996).

Our second stylized fact therefore translates in our model into the condition that

$$\sigma^2_{\varepsilon b}(vestibular) < \sigma^2_{\varepsilon w}(vestibular),$$

implying, for successful entrance into university, that

$$\begin{aligned} 1-\rho^2_w(vestibular) &= 1-\tfrac{\sigma^2_a}{\sigma^2_a+\sigma^2_{\varepsilon w}(vestibular)} \\ &< 1-\tfrac{\sigma^2_a}{\sigma^2_a+\sigma^2_{\varepsilon b}(vestibular)} = 1-\rho^2_b(vestibular) \end{aligned} . \qquad (9)$$

The marginal returns to entrance into university should therefore be substantially greater for Blacks than for Whites, in contrast to what obtains for the other years of educational attainment.

## 2.4 Testable hypotheses and implications

Our two stylized facts combined with a simple model of statistical discrimination lead to the following hypotheses that are testable within the context of a non-parametric wage equation.

First, the returns to all levels of schooling (apart from university admission) should be greater for Whites than for Blacks, with individuals of mixed race probably lying somewhere in between.[13] Second, and in contrast to other years of education, the returns to university admission should be greater for Blacks than for Whites. Third, given that university admission is considered to be an extremely accurate measure of true ability, in contrast to other schooling years, the returns to university admission should be greater than the returns to other years of schooling, irrespective of ethnic group. Moreover, this difference should be particularly pronounced for Blacks. These three hypotheses are illustrated in stylized form in Figure 1.

Note that the potential reversal in the relative returns to education between Blacks and Whites that should occur solely for university admission constitutes a test of statistical *versus* taste discrimination. If the latter constituted an accurate characterization of the Brazilian labor market, such a reversal should not occur. Similarly, this prediction of our theoretical model also constitutes a test of conventional human capital theory. If successful passage of the *vestibular* was simply an *additional* year of schooling such as any other, and did not furnish a signal that is subjectively interpreted by employers, one would expect, given that whites attend better schools than blacks, to see a higher *cumulative* return to this year of education for Whites than for Blacks (the cumulative return simply corresponds to the exponential transformation of the coefficient associated with the $12^{th}$ year of completed education in the non-parametric wage regression).

[13] We treat Blacks and Browns separately in order to be in accordance with the widespread belief that "browns" occupy a more privileged position than do blacks (see Skidmore, 1992).

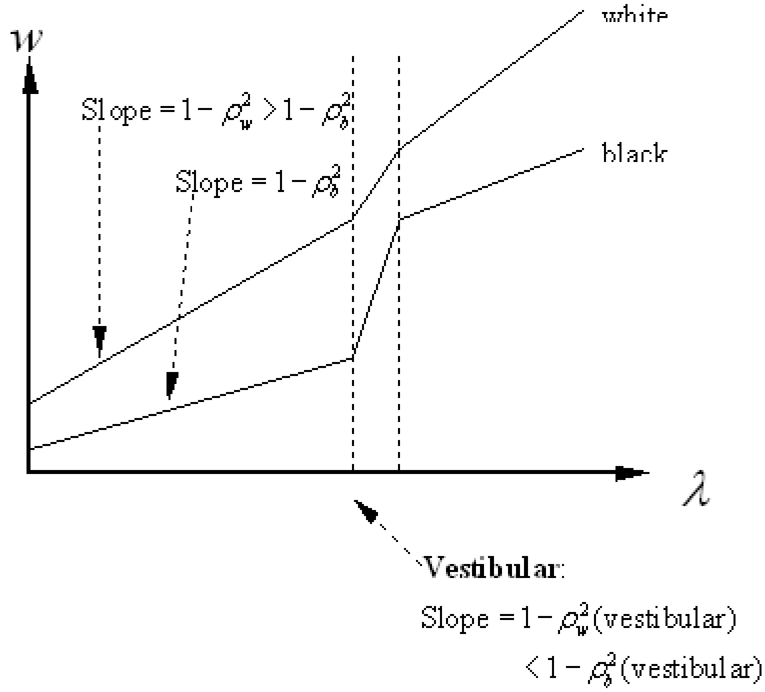


Figure 1: An illustration of the theoretical model

# 3 Empirical results

## 3.1 Descriptive statistics

The data originate with the *Pesquisa Emprego-Desemprego* (PED) survey, administered by the Department of Economics of the Federal University of Bahia for the Secretariat of State for Employment of the state government of Bahia. Our sample refers to wage earning males between 15 and 65 years of age over the $1996-1998$ period who inhabited the Metropolitan Region of Salvador.[14] Unfortunatly, the PED data do not allow one to distinguish between individuals who attended public *versus* private schools. The same

[14]Various age criteria in sample selection were tried. The empirical results that follow do not vary appreciably when this selection criterion is changed. Note that existing estimates of sheepskin effects in the US are based on samples of wage earners of between 25 and 64 years of age. Given Brazilian demographics, restricting one's attention to individuals older than 25 would substantially restrict our sample. Finally, note that the period in question followed the successful Real stabilization plan. Results do not change significantly when results are based on hourly wages expressed in US dollars, using either the official or black market (*paralelo*) exchange rate.

is true in the *Pesquisa National por Amostra de Domicílios* (PNAD) survey, except for the 1982 PNAD which would constitute an alternative, though somewhat dated, source of data). There is therefore no way to identify differences in $b$ explicitly in the data. Table 1 provides, by ethnic group, summary statistics on the variables that will be used in the empirical work, including details on the distribution of educational attainment by years of completed schooling, job tenure in the current job (in months), and age.[15]

Note that the PED educational attainment variable used in our study refers to *completed* years of education, not the number of years the individual has been in school. That is, an individual who has taken 10 years to reach satisfactory completion of the $8^{th}$ year of the primary educational system is classified as having completed 8 years of education. In terms of identifying sheepskin effects *per se*, the PED measure is therefore more satisfactory than the number of years of schooling variable in US data used by T. Hungerford and G. Solon (1987) or D. Belman and J. S. Heywood.(1991) On the other hand, true identification of sheepskin effects, and distinguishing them from the returns to education, would require data on actual diplomas received and the amount of time spent in school. As J. H. Park puts it: "... a stronger test would be to compare the earnings of those who have the degree and those who do not conditional on both groups having the same number of years of schooling".[16]

Sheepskin effects in the Brazilian educational system should obtain for three values of completed years of schooling: eight (primary school), eleven (high-school), and fifteen (basic college degree). Given our hypothesis concerning the signal furnished by admission to university another important sheepskin effect should obtain for twelve years of completed education.[17]

[15] The definition of an ethnic group in Brazil is fraught with difficulties. In particular, there is a bewilderingly large number of terms that are used to refer to a person's ethnic origin or skin color. Peggy A. Lovell (1999) who provides a useful summary of the current state of the literature, notes that a study by Moreno do Valle Silva (1996) finds that only 57 percent of individuals faced with an open question in terms of their color classify themselves into one of the three groups referred to here. On the other hand, when faced with a closed question expressed in terms of the three above-mentioned groups, all individuals are able and (more or less) willing to classify themselves. It is also important to note that the bipolar classification into whites and non-whites has been widely criticized in Brazil as being inappropriate and based on American stereotypes. In the Bahian data, moreover, the distinction between mixed and black groups would appear to be important (in particular with respect to inter-ethnic differences in the impact of university admission –see below). In the PED questionnaire, the relevant question is phrased in closed form and therefore classification into one of the three ethnic groups is not problematic. For purposes of comparison, we include results based on a bipolar classification in which the black and mixed categories are grouped together into an Afrobrazilian category. A fourth ethnic group constituted by individuals of Asian extraction was dropped as it comprised only five individuals.

[16] See Park (1999), Jaeger and Page (1996) and Kane and Rouse (1993) for the identification of sheepskin effects in US data using information on degrees and time in school.

[17] The educational system in Brazil is composed of three levels: "fundamental" education, secondary

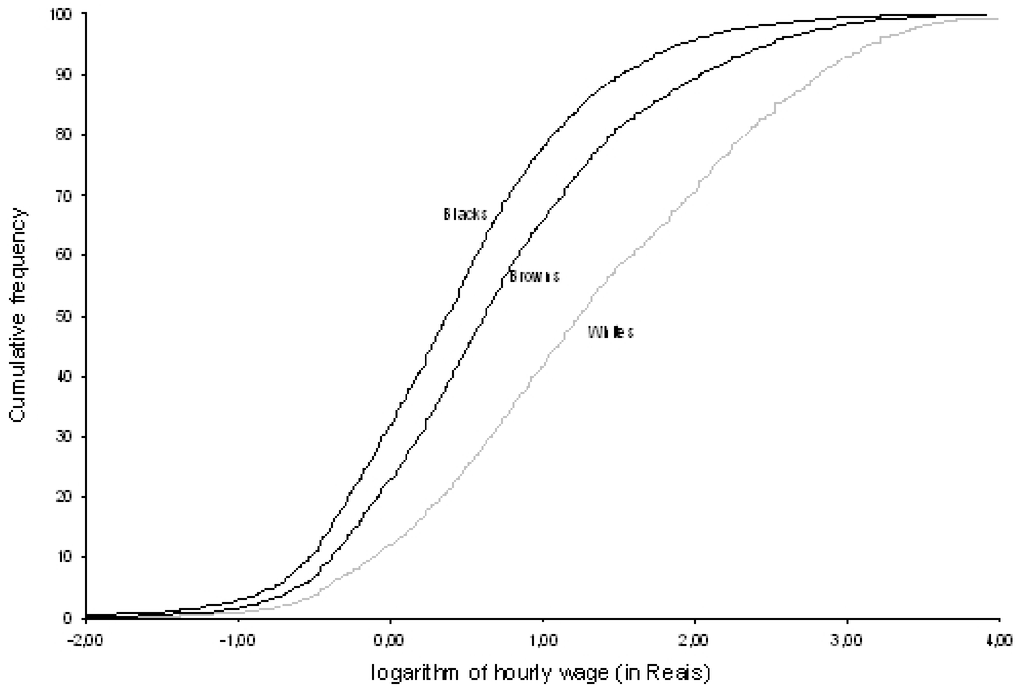


Figure 2: Cumulative densities of log hourly wage, by ethnic group

Figure 2 presents the cumulative density function of the logarithm of the hourly wage for our sample, by ethnic group. As should be obvious from the Figure, there is a clear shift to the right of the respective cumulative densities (as in first order stochastic dominance) as one moves from black, to the mixed, to the white ethnic group.

## 3.2 Nonparametric evidence

Figure 3 and Table 2 summarize the private rate of return to an additional year of schooling, as assesed by a semi-log wage equation where we control for job tenure (in

education (educação média) and university. The first level comprises eight years of education for children from ages 7 to 14, while secondary education lasts 3 years for youngsters aged between 15 and 17. Finally, higher education, which begins once an individual has successfully passed the *vestibular*, may be decomposed into two levels: the first level, corresponding to undergraduate students, which lasts from three to six years depending upon the subject matter, and the second level, corresponding to graduates. The latter are usually students who are pursuing a masters or a doctoral degree while simultaneously holding a job, preferably in the public sector (they are then considered to be employed).

months) and experience. The results are based on a specification in which educational attainment enters in non-parametric form, that is with a dummy variable for each year of completed schooling, estimated on the full sample with ethnic-specific coefficients for each explanatory variable.[18] The empirical results that lie behind theses results are summarized in Table 4.[19] In Table 3, we present results corresponding to pairwise comparisons of the returns to an additional year of education, by ethnic group. Two characteristics clearly distinguish the white group from the mixed and black groups.

First, as expected, there are high peaks for Whites associated with the returns to the three traditional values of completed years of schooling (8, 11 and 15). These returns, which are equal respectively to 22.8, 74.0 and 47.2 percent, may be in part associated with "conventional" sheepskin effects insofar as the intermediate (non “degree”) years of schooling do not display such high rates of return. The magnitude of these returns decreases as one moves from the white, to the mixed, to the black ethnic group. Indeed, while the rates of return associated with completion of primary and high school are equal to 15.4 and 37.6 percent for mixed group, Blacks display a rate of return equal to 24 percent for the completion of the high school but do not have statistically significant sheepskin effect associated with completing primary school. Finally, whereas the return to completing a four-year university degree (15 years of completed education) is particularly important for Whites, it is marginally so for individuals of mixed race and not at all so for Blacks. Note however that the rate of return to completing university is less easy to interpret insofar as course programs may last from a minimum of three to a maximum of six years.

The statistical tests for differences in the magnitudes of sheepskin effects by ethnic group, presented in Table 3, confirm the initial impressions gleaned from Table 2 and allow for a more formal test of the hypothesis advanced earlier. First, sheepskin effects associated with the completion of primary school are significantly larger for Whites and individuals of

[18] Before settling on the non-parametric specification used in the paper, we first estimated a traditional Mincerian equation in which the returns to schooling were linear for each ethnic group. The results confirmed that the earnings profiles by ethnic group had a pattern roughly consistent with that shown in Figure 1, to whit (i) returns to schooling and (ii) a constant which are greater for Whites than for individuals of mixed race or Blacks. The respective rates of return were equal to 12.7, 15.32 and 19.56 percent for Blacks, Mixed and Whites. Note that the assumption of linearity was rejected. Next, we adopted the standard spline specification which restricts the rates of return to be linear *within* each educational level (primary, secondary and university) and allows for sheepskin effects associated with admission to university as well as for the three years of education corresponding to the completion of primary, secondary and university education. These sheepskin effects are allowed for by including dummies variables for each of these completed years of education (education $\geq$ 8, 11, 12 and 15). The linearity assumption (by level of schooling) of the earnings profiles having again been strongly rejected, we adopted the non-parametric specification presented in the paper.

[19] Given that the coefficients associated with the educational attainment variables are large, we compute the rate of return to the $n^{th}$ year of schooling as $\exp\{\beta_n - \beta_{n-1}\} - 1$, where $\beta_n$ is the regression coefficient associated with $n$years of completed schooling. Taking the rate of return as being simply equal to the difference in coefficients is only valid for small values of $\beta_n$.

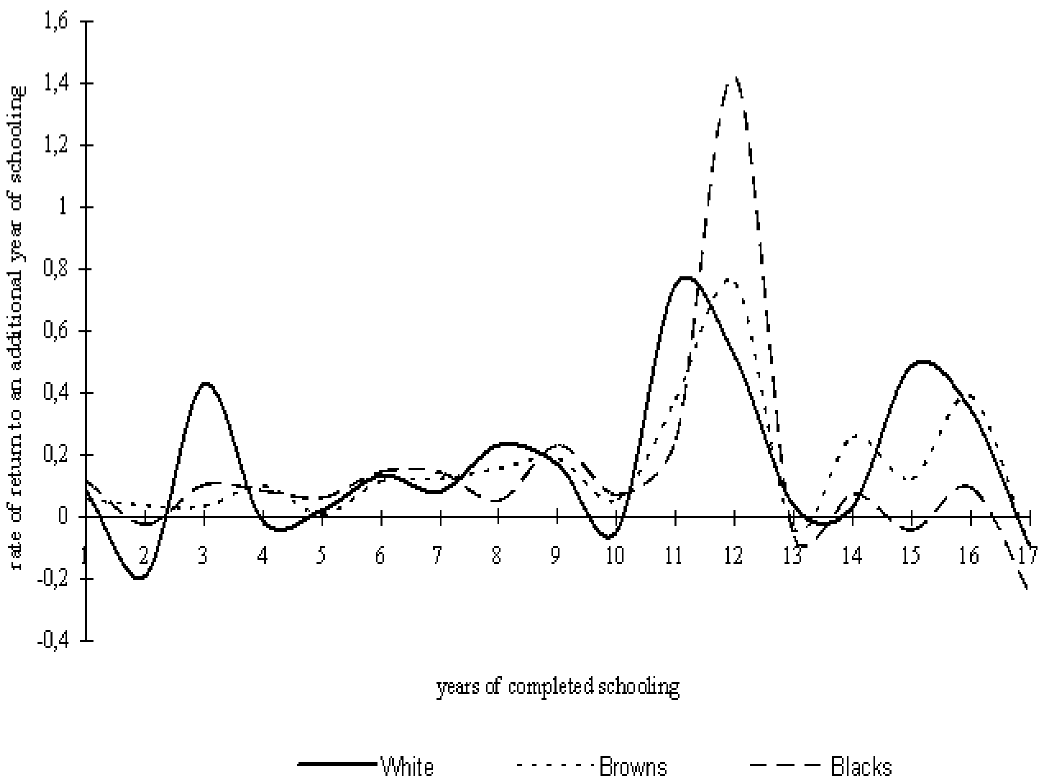


Figure 3: Estimates rate of return to an additional year of schooling

mixed race than they are for Blacks (recall that no statistically significant primary school sheepskin effect obtained for Blacks).

Second, sheepskin effects associated with the completion of secondary school are significantly smaller for blacks than for the two other ethnic groups. Concomitantly, the sheepskin effect associated with completion of a four-year university diploma is greater for whites than it is for the two other ethnic groups, but is not statistically significant in the Black-White comparison because of the large estimated standard error associated with the black university sheepskin.

Third, for Blacks, the highest peak in the earnings profile is associated with successful admission to university, which reflects having successfully passed the *vestibular* exam. The rate of return for the twelfth year of completed education is equal to an impressive 141 percent for Blacks. This is an exceptionally high number by any standard. For Whites and individuals of mixed race, on the other hand, the university admission effect is statistically significant but its magnitude is respectively one third and one half of what it is for Blacks. Thus, our tests confirm our results that there are statistically significant differences between the white group and the black group in the rate of return to the twelfth year of completed schooling.

This last result is consistent with Kenneth Arrow's hypothesis that admission to university constitutes an important screen. It is also consistent with the commonly accepted view in the social science literature which holds that blacks suffer from racial prejudice rather than "taste" discrimination, with employers being willing to pay a higher salary for Blacks who are able to demonstrate their potential productivity.[20] Note that the cumulative return to twelve years of completed education is greater for blacks than for whites. This clearly demonstrates that education plays the role of a signal of individual productivity in that, given the higher quality schools that Whites generally attend, their level of acquired ability should be higher than that of Blacks. Our results are therefore not, *a priori*, compatible with a simple human capital explanation.

Note also that for Blacks, the rate of return associated with completion of the first year of secondary education is particularly high compared to that which obtains for completion of primary school. This result means that completion of primary school is not considered to be a precise signal for Blacks. In this case, having successfully entered secondary school may have an effect similar to that associated with admission to university. However, there are no significant differences in this rate of return by ethnic group

Our main findings can therefore be summarized as follows:

(i) the returns to the $8^{th}$ , $11^{th}$ and $15^{th}$ completed year of education is significantly greater for Whites than it is for individuals of mixed race or Blacks;

[20] Skidmore (1992) and Hasenbalg and do Valle Silva (1992).

(ii) the returns to the $12^{th}$ year of completed education (admission to university as indicated by the successful completion of the first year) is significantly greater for Blacks than it is for non-Blacks.

(iii) for the blacks, the returns to the $12^{th}$year of completed education are significantly greater than the returns to completing 8, 11 or 15 years.

The extremely high rate of return to admission to university for individuals of mixed race and Blacks probably reflects in part conventional returns to education in that a considerable amount of academic work goes into the preparation of the *vestibular* university admission exam. As states above, it should be kept in mind that these peaks in the earnings profile may be in part the result of selectivity bias. However, it is likely that it is partly the result of a sheepskin-like signal insofar as there is no other reason that would lead to such large inter-ethnic differences in the rate of return to what is a relatively homogeneous exam.

## 4 Concluding Remarks

Our empirical results suggest that it is the *admission* of Blacks to university that yields a comparatively large return, whereas it is the *completion* of a degree (be it school or university) that counts for Whites, with individuals of mixed extraction lying somewhere in between.

Our model of statistical discrimination based on differences in the perception of the precision of the signal precision and on the relative costs and benefits to education explain these striking inter-ethnic differences in the returns to education in the MRS.

There is currently a debate in Brazil concerning affirmative action programs, with the suggestion of quotas for Afrobrazilians in the public sector and in some state universities. These policies, the object of which is to democratize university education and to reduce racial inequalities, are highly controversial. In particular, they run counter to the principle that admittance to an institution of learning be based on merit alone. They will also be efficient only if they are permanent: this violates the fundamental principle of affirmative action programs.[21] Concomitantly, however, alternatives measures such as policies supporting *pre-vestibular* programs (the cost of which is prohibitive for most Brazilians) have been put in place in order to encourage low-income Brazilians to enter university. In light of our results, this may indeed be a manner of facilitating the access of Afrobrazilians to higher education, and of remedying the deficiencies in the public educational system at the primary and secondary levels, without impugning merit-based access to university. Our results also suggest that much effort needs to be made in order to improve the quality of public schools particularly in those neighborhoods inhabited by Afrobrazilians.

[21] See Antonio Guimarães and Sergio Alfredo (1999) and Bernardino (2002). For a theoretical approach, see for example Coate and Loury (1983).

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## 5 Appendix: derivation of the theoretical model of statistical discrimination applied to the Brazilian Nordeste

To apply the undetermined coefficients method, we write:

$$h = \beta_0 + \beta_a a + \beta_\varepsilon \varepsilon.$$

The firm sets its wage on the basis of the expected marginal productivity of the worker, conditional on the signal $\lambda$:

$$w = E[\theta|\lambda] = E[\lambda - \varepsilon|\lambda] = \lambda - E[\varepsilon|\lambda].$$

Note that one can write the signal as:

$$\lambda = \theta + \varepsilon = \underbrace{a + bh}_{\theta} + \varepsilon = \underbrace{a + b\underbrace{(\beta_0 + \beta_a a + \beta_\varepsilon \varepsilon)}_{h}}_{\theta} + \varepsilon,$$

which by substitution can be rewritten as:

$$\begin{aligned} \lambda &= a + b(\beta_0 + \beta_a a + \beta_\varepsilon \varepsilon) + \varepsilon \\ &= b\beta_0 + (1 + b\beta_a)a + (1 + b\beta_\varepsilon)\varepsilon. \end{aligned}$$

Since $(a, \varepsilon) \sim N(\mu_a, \mu_\varepsilon, \sigma_a^2, \sigma_\varepsilon^2, 0)$, the signal is distributed according to the (univariate) normal density function with mean:

$$\mu_\lambda = E[\lambda] = b\beta_0 + (1 + b\beta_a)\mu_a + (1 + b\beta_\varepsilon)\mu_\varepsilon,$$

and variance:

$$\sigma_\lambda^2 = var[\lambda] = (1 + b\beta_a)^2\sigma_a^2 + (1 + b\beta_\varepsilon)^2\sigma_\varepsilon^2.$$

Concomitantly, the signal $\lambda$ and the noise $\varepsilon$ are jointly distributed according to the bivariate normal density with means $(\mu_\lambda, \mu_\varepsilon)$ and variances $(\sigma_\lambda^2, \sigma_\varepsilon^2)$. The covariance between the signal and the noise is given by:

$$cov[\lambda, \varepsilon] = E[(b\beta_0 + (1 + b\beta_a)a + (1 + b\beta_\varepsilon)\varepsilon)\varepsilon] - \mu_\lambda\mu_\varepsilon$$

which can be expressed as:

$$cov[\lambda, \varepsilon] = [b\beta_0 + (1 + b\beta_a)\mu_a - \mu_\lambda]\mu_\varepsilon + (1 + b\beta_\varepsilon)\mu_\varepsilon^2 + (1 + b\beta_\varepsilon)\sigma_\varepsilon^2.$$

Since

$$\mu_\lambda = b\beta_0 + (1 + b\beta_a)\mu_a + (1 + b\beta_\varepsilon)\mu_\varepsilon,$$

it follows that

$$b\beta_0 + (1 + b\beta_a)\mu_a = \mu_\lambda - (1 + b\beta_\varepsilon)\mu_\varepsilon.$$

Substitution then yields:

$$cov[\lambda, \varepsilon] = (1 + b\beta_\varepsilon)\sigma_\varepsilon^2.$$

The correlation between the signal and the noise is therefore given by:

$$\begin{aligned} \rho[\lambda, \varepsilon] &= \frac{cov[\lambda, \varepsilon]}{\sigma_\lambda \sigma_\varepsilon} \\ &= \frac{(1 + b\beta_\varepsilon)\sigma_\varepsilon^2}{\sigma_\lambda \sigma_\varepsilon} \\ &= (1 + b\beta_\varepsilon)\frac{\sigma_\varepsilon}{\sigma_\lambda}. \end{aligned}$$

We can now compute the expectation of the noise, conditional on the signal:

$$\begin{aligned} E[\varepsilon|\lambda] &= \mu_{\varepsilon|\lambda} \\ &= \mu_\varepsilon + \rho[\lambda, \varepsilon]\frac{\sigma_\varepsilon}{\sigma_\lambda}(\lambda - \mu_\lambda) \\ &= \mu_\varepsilon + (1 + b\beta_\varepsilon)\frac{\sigma_\varepsilon^2}{\sigma_\lambda^2}(\lambda - \mu_\lambda). \end{aligned}$$

Similarly, one can compute the conditional variance as:

$$\begin{aligned} var[\varepsilon|\lambda] &= \sigma_\varepsilon^2(1 - [\rho[\lambda, \varepsilon]]^2) \\ &= \sigma_\varepsilon^2 - (1 + b\beta_\varepsilon)^2\frac{\sigma_\varepsilon^4}{\sigma_\lambda^2}. \end{aligned}$$

Now recall that the employer sets the wage such that: $w = \lambda - E[\varepsilon|\lambda]$.Substitution yields:

$$w = \lambda - \mu_\varepsilon - (1 + b\beta_\varepsilon)\frac{\sigma_\varepsilon^2}{\sigma_\lambda^2}(\lambda - \mu_\lambda).$$

This simplifies to:

$$w = \left(1 - (1 + b\beta_\varepsilon)\frac{\sigma_\varepsilon^2}{\sigma_\lambda^2}\right)\lambda + (1 + b\beta_\varepsilon)\frac{\sigma_\varepsilon^2}{\sigma_\lambda^2}\mu_\lambda - \mu_\varepsilon.$$

Now consider the worker's optimization problem:

$$\max_{\{h\}} \underbrace{\left(1 - (1 + b\beta_\varepsilon)\frac{\sigma_\varepsilon^2}{\sigma_\lambda^2}\right)\underbrace{(a + bh + \varepsilon)}_{\lambda} + (1 + b\beta_\varepsilon)\frac{\sigma_\varepsilon^2}{\sigma_\lambda^2}\mu_\lambda - \mu_\varepsilon}_{w} - \frac{c}{2}h^2.$$

The First Order Condition is given by:

$$\left(1-(1+b\beta_\varepsilon)\frac{\sigma_\varepsilon^2}{\sigma_\lambda^2}\right)b-ch^*=0,$$

allowing one to write:

$$h^*=\left(1-(1+b\beta_\varepsilon)\frac{\sigma_\varepsilon^2}{\sigma_\lambda^2}\right)\frac{b}{c}.$$

Since the level of investment in human capital is non-stochastic, one then sets $\beta_a=\beta_\varepsilon=0$, which implies that $\sigma_\lambda^2=\sigma_a^2+\sigma_\varepsilon^2$, yielding:

$$\begin{aligned} h^* &= \left(\frac{\sigma_\lambda^2-\sigma_\varepsilon^2}{\sigma_\lambda^2}\right)\frac{b}{c} \\ &= \left(\frac{\sigma_a^2}{\sigma_\lambda^2}\right)\frac{b}{c}. \end{aligned}$$

This corresponds to equation (5) in the text. In equilibrium the firm's wage offer curve is given by:

$$\begin{aligned} w &= \left(1-\frac{\sigma_\varepsilon^2}{\sigma_\lambda^2}\right)\lambda+\frac{\sigma_\varepsilon^2}{\sigma_\lambda^2}\mu_\lambda-\mu_\varepsilon \\ &= \left(\frac{\sigma_a^2}{\sigma_\lambda^2}\right)\lambda+\mu_a+\left(\frac{\sigma_a^2}{\sigma_\lambda^2}\right)\mu_\lambda \\ &= \left(\frac{\sigma_a^2}{\sigma_\lambda^2}\right)\lambda+\left(1-\frac{\sigma_a^2}{\sigma_\lambda^2}\right)\mu_\lambda \end{aligned}$$

which corresponds to equation (3) in the text. Moreover, the equilibrium marginal productivity of a worker is given by:

$$\begin{aligned} \theta^* &= a+bh^* \\ &= a+\frac{b^2}{c}\left(\frac{\sigma_a^2}{\sigma_\lambda^2}\right), \end{aligned}$$

which corresponds to equation (6) in the text.

| | Full sample | White | Mixed | Black | Afro Brazilians |
|---|---|---|---|---|---|
| Number of observations | 17,449 | 3,236 | 9,993 | 4,220 | 14,213 |
| (% of sample) | (100.00) | (18.53) | (57.24) | (24.18) | (81.47) |
| Hourly wage in $Reais | 0.7531 | 1.306 | 0.714 | 0.419 | 0.627 |
| (std. deviation) | (0.99) | (1.11) | (0.94) | (0.83) | (0.92) |
| Age : mean | 32.63 | 34.12 | 32.36 | 32.11 | 32.29 |
| (std. deviation) | (10.85) | (11.27) | (10.64) | (10.92) | (10.73) |
| Job tenure (in months) | 62.66 | 72.26 | 61.95 | 56.96 | 60.47 |
| (std. deviation) | (81.95) | (89.30) | (81.09) | (77.35) | (80.03) |
| Educational attainment | | | | | |
| Yrs. of completed school. | 8.04 | 10.44 | 7.91 | 6.51 | 7.50 |
| (std. deviation) | (4.10) | (4.04) | (3.94) | (3.65) | (3.91) |
| Yrs. of completed school. number of observations | | | | | |
| 1 | 479 | 37 | 275 | 167 | 442 |
| 2 | 567 | 48 | 319 | 200 | 519 |
| 3 | 862 | 81 | 479 | 302 | 781 |
| 4 | 1617 | 154 | 932 | 531 | 1463 |
| 5 | 1507 | 133 | 890 | 484 | 1374 |
| 6 | 884 | 93 | 548 | 243 | 791 |
| 7 | 905 | 95 | 536 | 274 | 810 |
| 8 (primary school) | 1785 | 228 | 1079 | 478 | 1557 |
| 9 | 792 | 101 | 496 | 195 | 691 |
| 10 | 686 | 125 | 408 | 153 | 561 |
| 11 | 4515 | 1013 | 2675 | 827 | 3502 |
| 12 (university) | 183 | 89 | 77 | 17 | 94 |
| 13 | 267 | 119 | 123 | 25 | 148 |
| 14 | 313 | 131 | 163 | 19 | 182 |
| 15 (four-year degree) | 1058 | 519 | 482 | 57 | 539 |
| 16 | 308 | 156 | 140 | 12 | 152 |
| 17 | 105 | 62 | 39 | 4 | 43 |

Table 1: Summary statistics

| Years of completed schooling | White | [p-value] | Mixed | [p-value] | Black | [p-value] |
|---|---|---|---|---|---|---|
| 1 | 0.0805 | 0.661 | 0.0561 | 0.318 | 0.1148 | 0.151 |
| 2 | −0.1915 | 0.161 | 0.0368 | 0.465 | −0.0245 | 0.706 |
| 3 | 0.4263 | 0.024 | 0.0341 | 0.451 | 0.1019 | 0.079 |
| 4 | −0.0150 | 0.870 | 0.0984 | 0.008 | 0.0824 | 0.068 |
| 5 | 0.0199 | 0.809 | 0.0066 | 0.809 | 0.0603 | 0.120 |
| 6 | 0.1314 | 0.208 | 0.1140 | 0.000 | 0.1446 | 0.003 |
| 7 | 0.0801 | 0.401 | 0.1217 | 0.001 | 0.1426 | 0.012 |
| 8 | 0.2303 | 0.010 | 0.1551 | 0.000 | 0.0510 | 0.292 |
| 9 | 0.1682 | 0.058 | 0.1865 | 0.000 | 0.2300 | 0.000 |
| 10 | −0.0454 | 0.588 | 0.0534 | 0.667 | 0.0703 | 0.324 |
| 11 | 0.7500 | 0.000 | 0.3778 | 0.000 | 0.2478 | 0.000 |
| 12 | 0.5181 | 0.000 | 0.7540 | 0.000 | 1.4182 | 0.000 |
| 13 | 0.0361 | 0.698 | −0.0394 | 0.667 | −0.0629 | 0.750 |
| 14 | 0.0329 | 0.697 | 0.2573 | 0.009 | 0.0741 | 0.741 |
| 15 | 0.4862 | 0.000 | 0.1207 | 0.098 | −0.0433 | 0.825 |
| 16 | 0.3443 | 0.000 | 0.3886 | 0.000 | 0.0935 | 0.712 |
| 17 | −0.0953 | 0.435 | −0.0974 | 0.395 | −0.2468 | 0.457 |

Table 2: Rate of return to an additional year of schooling by ethnic group

| Years of completed schooling | Black − Mixed | [p-value] | White − Mixed | [p-value] | White − Black | [p-value] |
|---|---|---|---|---|---|---|
| 1 | 0.0587 | 0.548 | 0.0244 | 0.898 | −0.0343 | 0.864 |
| 2 | −0.0613 | 0.456 | −0.2283 | 0.117 | −0.167 | 0.270 |
| 3 | 0.0678 | 0.357 | 0.3922 | 0.043 | 0.3244 | 0.102 |
| 4 | −0.016 | 0.782 | −0.1134 | 0.263 | −0.0974 | 0.354 |
| 5 | 0.0537 | 0.263 | 0.0133 | 0.856 | −0.0404 | 0.681 |
| 6 | 0.0306 | 0.617 | 0.0174 | 0.859 | −0.0132 | 0.926 |
| 7 | 0.0209 | 0.760 | −0.0416 | 0.675 | −0.0625 | 0.565 |
| 8 | −0.1041 | 0.083 | 0.0752 | 0.446 | 0.1793 | 0.083 |
| 9 | 0.0435 | 0.553 | −0.0183 | 0.896 | −0.0618 | 0.607 |
| 10 | 0.0169 | 0.846 | −0.0988 | 0.294 | −0.1157 | 0.290 |
| 11 | −0.13 | 0.147 | 0.3722 | 0.004 | 0.5022 | 0.000 |
| 12 | 0.6642 | 0.124 | −0.2359 | 0.198 | −0.9001 | 0.035 |
| 13 | −0.0235 | 0.914 | 0.0755 | 0.560 | 0.099 | 0.648 |
| 14 | −0.1832 | 0.454 | −0.2244 | 0.086 | −0.0412 | 0.867 |
| 15 | −0.164 | 0.438 | 0.3655 | 0.003 | 0.5295 | 0.019 |
| 16 | −0.2951 | 0.271 | −0.0443 | 0.714 | 0.2508 | 0.341 |
| 17 | −0.1809 | 0.980 | 0.0024 | 0.670 | 0.1833 | 0.668 |

Table 3: Estimated differences in the rate of return to an additional year of schooling : pairwise comparisons. by ethnic group

| | Full sample | White | Mixed | Black | Afro Brazilians |
|---|---|---|---|---|---|
| Intercept | −0.9437 | −0.7054 | −0.8788 | −1.1725 | −0.9804 |
| | −26.580 | −5.897 | −18.471 | −19.128 | −26.207 |
| Experience | 0.0566 | 0.0447 | 0.0559 | 0.0684 | 0.0596 |
| | 33.666 | 11.101 | 24.848 | 21.285 | 32.310 |
| $(\text{Experience})^2$ | −0.0007 | −0.0005 | −0.0007 | −0.0009 | −0.0008 |
| | −22.233 | −6.718 | −16.400 | −15.041 | −21.871 |
| Job tenure | 0.0042 | 0.0045 | 0.0043 | 0.0043 | 0.0043 |
| | 21.364 | 10.160 | 16.838 | 11.164 | 19.712 |
| $(\text{Job tenure})^2$ | $-7\times10^{-6}$ | $-7\times10^{-6}$ | $-8\times10^{-6}$ | $-9\times10^{-6}$ | $-8\times10^{-6}$ |
| | −11.443 | −5.705 | −8.827 | −6.671 | −10.641 |
| Yrs. completed schooling | | | | | |
| 1 year | 0.0830 | 0.0775 | 0.0545 | 0.1087 | 0.0811 |
| | 1.991 | 0.455 | 1.026 | 1.513 | 1.904 |
| 2 years | 0.0766 | −0.1350 | 0.0907 | 0.0838 | 0.0916 |
| | 1.945 | −0.875 | 1.733 | 1.320 | 2.263 |
| 3 years | 0.1601 | 0.22 | 0.1243 | 0.1809 | 0.1478 |
| | 4.335 | 1.622 | 2.517 | 3.018 | 3.871 |
| 4 years | 0.2410 | 0.2048 | 0.2182 | 0.2602 | 0.2393 |
| | 7.147 | 1.664 | 4.851 | 4.684 | 6.845 |
| 5 years | 0.2659 | 0.2246 | 0.2248 | 0.3188 | 0.2650 |
| | 7.734 | 1.752 | 4.942 | 5.594 | 7.462 |
| 6 years | 0.3872 | 0.3481 | 0.3328 | 0.4539 | 0.3840 |
| | 10.539 | 2.621 | 6.907 | 7.294 | 10.099 |
| 7 years | 0.5023 | 0.4253 | 0.4477 | 0.5872 | 0.5042 |
| | 13.582 | 3.321 | 9.195 | 9.223 | 13.070 |
| 8 years | 0.6318 | 0.6326 | 0.5919 | 0.6370 | 0.6203 |
| | 18.255 | 5.163 | 12.967 | 10.837 | 17.256 |
| 9 years | 0.8115 | 0.7881 | 0.7629 | 0.8441 | 0.8042 |
| | 20.895 | 5.655 | 14.940 | 12.712 | 19.867 |
| 10 years | 0.8596 | 0.7415 | 0.8150 | 0.9120 | 0.8636 |
| | 20.895 | 5.655 | 15.053 | 12.051 | 19.762 |
| 11 years | 1.2163 | 1.3012 | 1.1355 | 1.1335 | 1.1611 |
| | 35.867 | 11.068 | 25.194 | 19.320 | 32.632 |
| 12 years | 1.8304 | 1.7187 | 1.6975 | 2.0165 | 1.7925 |
| | 31.330 | 12.841 | 19.189 | 11.447 | 22.935 |
| 13 years | 0.8208 | 1.7542 | 1.6572 | 1.9515 | 1.7489 |
| | 35.302 | 13.288 | 23.128 | 14.021 | 28.162 |
| 14 years | 1.9514 | 1.7866 | 1.8862 | 2.0230 | 1.9562 |
| | 38.771 | 13.743 | 27.054 | 11.578 | 31.607 |
| 15 years | 2.1760 | 2.1829 | 2.0000 | 1.9788 | 2.0465 |
| | 54.040 | 18.076 | 35.798 | 14.889 | 42.624 |
| 16 years | 2.4832 | 2.4788 | 2.3285 | 2.0682 | 2.3624 |
| | 48.024 | 19.578 | 30.006 | 10.017 | 33.424 |
| 17 years | 2.4104 | 2.3786 | 2.2260 | 1.7847 | 2.2388 |
| | 25.705 | 13.882 | 18.891 | 4.481 | 19.390 |
| $\sigma$ | 0.6622 | 0.7104 | 0.6505 | 0.6252 | 0.6452 |
| $\overline{R}^2$ | 0.5600 | 0.5953 | 0.5272 | 0.4467 | 0.5136 |
| Number of obs. | 17,449 | 3,236 | 9,993 | 4,220 | 14,213 |

Table 4: Wage equations, by ethnic group (t-statistics below coefficients)