THE ECONOMIC COST OF GENDER DISCRIMINATION IN THE BRAZILIAN LABOUR MARKET

Abstract:
Gender discrimination in the labor market can take several forms, creating wage differentials that are unrelated to productivity. The existence of these differences implies an economic cost for the economy in terms of production and labor income. In this article, these losses were estimated through the interaction of wage decomposition models and simulations with an input-output model. The wage decomposition was calculated at different points of the income distribution, using the recentered influence function (RIF) developed by Firpo *et al*. (2009). Using the results of the decomposition, it was possible to calculate individual wages adjustments, following steps proposed by Oaxaca and Ranson (2003), so that all individuals are remunerated according to their observable characteristics as well as the non-discriminated group. In turn, these estimates were used to compile two vectors of shock, for the simulation of rising nominal costs of labor, and consumption, considering households divided by income deciles. The wage decomposition model was estimated using the National Household Survey (from Portuguese PNAD – Pesquisa Nacional por Amostra de Domicílios) for 2013. The input-output matrix estimate was based on the supply and use tables for 2013, according to the procedures described in Guilhoto and Sesso Filho (2005) and the hypothesis of "industry-based" technology. The first simulation operates basically as the following: i) the adjustment was calculated at the individual level, ii) the change in sectorial labor cost depends on the total adjustment owed to all women working in that sector; iii) the increase in wages is incorporated as a rise in production cost, that causes expanding prices; iv) using Leontief price model assumptions, if the amount of money in the economy is the same, final demand is adjusted and the production falls; v) employment follows production. In the second simulation, it was assumed that the economy changed due to the first shock. Therefore, using the updated Leontief matrix, it was applied a second shock increasing consumption for all households, according to the income rise in each decile calculated at individual level and aggregated by income decile. Consequently, in the second simulation, consumption increases production; and employment follows production. The simulation results indicate that the income effect generated through consumption overcomes the price effect, due to the wage rising in terms of production and welfare but not in terms of employment. Nonetheless, the results are very heterogeneous across sectors and households.
Key-words: discrimination, women, wage decomposition, input-output simulation
JEL Classification: J7, C21, C67

1. INTRODUCTION

Discrimination in the labor market has received particular attention among researchers. As Cain (1984) argues, wages are the most important source of income that people can earn by their own effort, making the labor market an important mechanism of social distribution, with important consequences on inequality (VEMMAN, 2010). In this regard, Brazil is a prominent example. In particular, since the early 2000s, the country has adopted social policies that aimed to reduce income inequalities and foster social inclusion. Examples are the “Bolsa Família” program, and other initiatives, such as “Brasil Carinhoso” and “Brasil sem Miséria” (PORTAL BRASIL, 2013). While these policies have generated results that are positive in aggregate, research has been lacking on their contribution to the reduction of current levels of inequality.

Gender discrimination is one those factors, as it generates significant and persistent wage gaps (CAIN, 1999), through which many forms of discrimination are associated with poverty (CAMBOTA and MARINHO, 2006). In this way, the labor market at the same time reveals and generates inequalities (BARROS, *et al*., 2006). As a consequence, individuals discriminated against are concentrated in the bottom part of the income distribution, in the poorest regions, and having limited opportunities for social advancement. These happens not only directly due to discrimination, but also by reduced access to educational and professional training (CAMBOTA and MARINHO, 2006; GUIMARÃES, 2006; GRADÍN, 2009).

Even so, income differences cannot be directly taken as evidence of discrimination (HECKMAN, 1998; BLANK *et al.*, 2004), since they constitute the result of a set of factors and disparities in the labor market (BLANK *et al*., 2004). Each group has its own economically relevant characteristics that are valued differently in the market and directly explain the differences in labor earnings (STIGLITZ, 1973). In this sense, there is discrimination in the labor market when equally productive individuals are evaluated differently based on nonproductive aspects, such as race and gender (BECKER, 1971, ARROW, 1973).

From a neoclassical economic theory perspective, the great challenge, according to Cohn (2000), was responding to the major paradox of discrimination: after all, if firms are fully rational, gender and race discrimination could not exist. More than that, if equally productive individuals do not receive the same wages, there must be some market failure, such as information asymmetry, or other mechanisms that act directly on the wage determination and which cannot be directly explained by traditional models.

Such questions supported the development of the literature of economic discrimination, from Becker (1971) with his definitions of tastes and preferences for discrimination, towards Phelps (1972) and Arrow (1973). The last two authors created the concept of statistical discrimination, giving certain rationality in determining discriminatory wages. For them, wage differentiation over groups would be a direct consequence of asymmetric information in the labor market with respect to qualifications and investments in human capital.

Notwithstanding the development of an extensive literature on these theoretical models, it has proven very difficult to test them empirically, mainly due to lack of data. Even with more detailed data sets, it remains difficult to determine the exact nature of discrimination (ALTONJI and BLANK, 1999). In practice, according to O'Neill and O'Neill (2005), the distinction between statistical discrimination derived from prejudice and discrimination is far from straightforward, since none of the theories of discrimination in the labor market is satisfactory to explain all the variation observed wage differentials in society (CAIN, 1984; O'NEILL and O'NEILL, 2005; LANG and LEHMANN, 2011).

For these reasons, researchers, according to O'Neill and O'Neill (2005), attempted to explore broader issues that can be directly measured. Therefore, the empirical literature has been more targeted to test whether there is discrimination, than to test specific theoretical models (FANG and MORO, 2011).

In this context, the decomposition of wages, suggested by Blinder (1973) and Oaxaca (1973), are the most widely used methods to measure discrimination in the labor market, and can be applied even without data specifically designed for discrimination analysis. In these models, given the concept of discrimination in the labor market, the wage differential between groups can be explained mainly by two factors: changes in the distribution of observable characteristics, and discrimination. Accordingly, the method determines to what extent wage differentials are indeed differences in productivity or are related to other factors.

At first, the decomposition methods were concentrated on measuring discrimination in average wages between groups. However, some authors have observed that the effect of the covariates may not be constant along the distribution (MACHADO and MATA, 2005), and wage inequality can be explained by changes in observed variables with specific implications for particular points along the income distribution (FORTIN *et al*, 2011). Nevertheless, the methodological refinements later developed, some questions remain open: What are the consequences of gender and race discrimination for households' welfare? What are the consequences for the economy as a whole?

According to D'Amico (1987), discrimination incurs a cost to society, inevitably leading to an efficiency loss due to underutilization of productive resources that further discourage human capital investment. In this sense, the discrimination produces a loss of productivity, and consequently the level of production falls below its potential. To clarify these issues, it is necessary to explain the connections between the decisions of individuals and firms, and the inclusion of these in the productive system. From the individual perspective, discrimination negatively affects decisions directly related to the labor market, like investment in human capital, occupational choice and job supply itself, but also has a negative impact on consumption. On the other hand, from the perspective of firms, although the equalization of wages is usually seen as a cost, the indirect effects of discrimination on the labor supply and demand counteracts the cost.

In order to capture some of these effects, this paper proposes a bottom-up integration between a micro model of wage discrimination and an input-output model. At the micro level (individual), the first step was to calculate the wage a woman should receive if there was no gender discrimination in Brazilian labor market, and in the second step these values were used in two complementary shocks in an input-output model. In the first step, we calculated the effect of rising wages over sectorial prices, using a Leontief price model, secondly, we calculated the effect on consumption.

The paper is divided as follows: the next section briefly describes general aspects of the empirical literature, while section three describes the methodology used, including the wages decomposition, the wage adjustment method proposed by Oaxaca and Regan (2003), and the proposed simulations using input-output analysis. Section four shows the results and, the final section describes some final remarks.

2. EMPIRICAL LITERATURE

In the empirical literature, it is possible to identify several studies conducted using Brazilian data. These studies range from direct applications of the Blinder and Oaxaca method, as in Leme and Wajnman (2000); Campante *et al.* (2004); Gilberti and Menezes-Filho (2005), Kings and Crespo (2005), Guimarães (2006); Matos and Machado (2006) and Cacciamali *et al.* (2009), as well as some methodological extensions, for instance, Arcand and D'Hombres (2004) and Milk (2005). For the surveyed literature, the database used was PNAD, with applications for several years. Moving forward to decompositions along the distribution, notable studies are those of Smith (2000), Guimarães (2004); Crankshaft and Marino (2005), Oliveira and Rios-Neto (2006); Bartalotti and Biderman (2007) Silver (2009), Coelho *et al* (2010) and Arraes *et al.*,2014).

Overall, there are some regularities. When compared to the group of white men, the wage differential for white women is a result of discrimination in the labor market, i.e., the result of unobserved factors that lead to low return from their observed characteristics. In turn, the gap for black men is a result of pre-market discrimination, resulting in lower levels of education and/or qualification. Finally, and as expected, the case of black women combines the previous two cases (SOARES, 2000; BIDERMAN and GUIMARÃES, 2004; BARTALLOTI, 2007; CAMBOTA and MARINHO, 2005; CACCIAMALI *et al.*, 2009).

In the international literature, there are several applications of methods involving quantile regressions; they reinforce the existence of a relationship between wage differentials and social mobility, showing that discrimination not only has different impacts at different points of the distribution, but also increases with the wage level. This behavior is known as "glass ceiling,"[1] and was observed for Brazil in Campante *et al.* (2004); Gilberti and Menezes-Filho (2005) Milk (2005); Bartalotti (2007); Cacciamali *et al.* (2009); Prata (2009) and Coelho *et al.* (2010), for Colombia in Badel and Penha (2010), to the United States in Kassenböhmer and Sinning (2010), to Australia in Kee (2006) and to Europe in Albrecht *et al.* (2003, 2009), Arulampalam *et al.* (2007) and de la Rica *et al.* (2008), among others.

In turn, when the wage gap is larger at the beginning of the distribution, it can be said that there is a "sticky floor" preventing people from moving forward, as noted by Arulampalam *et al.* (2007) for Spain (between fifty and tenth percentile, and between the twenty-fifth and tenth percentile) and Italy (only between the fiftieth and tenth percentile), and De la Rica *et al*. (2008) for low-skilled workers in Spain.

Although the main advantage of the method is the possibility of application in the absence of specific data on discrimination according to Altonji and Blank (1999), even if the decompositions are consistent with

[1] Campante *et al* (2004) defines the glass ceiling as an "elitist profile" of the wage distribution.

the hypothesis of the presence of discrimination, a few methodological caveats are necessary: i) model specification (as a predictor of individual wages), ii) measurement errors, and iii) omitted variables.

First, it is necessary to include a complex set of attributes relating wages to individual's productivity, which in practice is not available (GUIMARÃES, 2006). There are several variables that affect the wages but cannot be captured by more general research, as in the case of PNAD. As a result, the variables usually used as a proxy for productivity are full of measurement errors, at the same time other variables that could affect wages are not available (GUIMARÃES, 2006).

The specification problem is directly related to the complexity of wage determination. According to Figueiredo and Silva (2012), part of the income is determined by a set of effort variables (such as educational level, the decision to migrate and hours worked per year). On the other hand, another part is determined by factors over which the individual does not have control, but that indirectly affect their choices, called situational variables (such as level of parents' education and occupation, race, gender, age, and birth region). In this way, the results are limited to the proxies provided by surveys, which are subject to specification errors.

Even with all possible control variables, according to Darity and Mason (1998), Altonji and Blank (1999) and Tomaskovic-Devey *et al.* (2005) discrimination affects investments in human capital (and other pre-labor market features) leading to underestimation of discrimination, as any variable investment in human capital carries a component of pre-market discrimination. Therefore, the model will inevitably be subject to an omitted variables bias related to human capital decisions, and individual preferences, which are correlated with wages and may overestimate or underestimate the differential unexplained (HECKMAN, 1998; ALTONJI and BLANK, 1999; BLANK *et al.*, 2004).

In this regard, as suggested by Blank *et al.* (2004), it will always be difficult to argue that any set of variables chosen to explain wages is a complete set of variables related to worker productivity. Therefore, given the data available, following the advice of Guimarães (2006), the researcher must specify the model as fully as possible and interpret the results with caution. Doing so, the wage decompositions can be an important tool to understand what factors are related to observable characteristics that determine wages and its variations, while measuring the magnitude of the differences that cannot be explained by these attributes (BLANK *et al*., 2004).

3. METHODOLOGY

Schematically, the interconnection between the wage decomposition model and the input-output simulation can be seen in Figure 1. From the results of the decomposition (at different points of the income distribution, calculated using the methodology of Firpo *et al*. (2009) it was possible to calculate individual wages adjustments, following steps proposed by Oaxaca and Ranson (2003), so that all individuals are now remunerated according to their observable characteristics as well as the non-discriminated group (white men). In turn, these estimates were used to compile the vectors of shock, for the simulation of rising nominal costs of labor, and consumption. The following sections discuss each method in particular.

<<insert figure 1 here>>

The wage decomposition model was estimated using the National Household Survey (from Portuguese PNAD – Pesquisa Nacional por Amostra de Domicílios) for 2013 (IBGE, 2016a). The input-output matrix estimate was based on the supply and use tables of the Brazilian Institute of Geography and Statistics (IBGE) for 2013, according to the procedures described in Guilhoto and Sesso Filho (2005) and the hypothesis of "industry-based" technology (Miller and Blair, 2009). The household consumption disaggregation into different income deciles was made from data in the Household Budget Survey (IBGE, 2016b), while labor incomes were disaggregated according to data from the National Household Sample Survey (PNAD).

3.1. Wage Decomposition and Adjustment

For this paper, we used the recentered influence function (RIF) developed by Firpo *et al.* (2009)[2]. An extensive discussion and comparisons between different types of wage decomposition methodologies can be seen in Fortin *et al.* (2011). The methodology facilitated the estimation of different wage equations for ten income deciles. Therefore, it is possible to estimate how much of the wage differentials between men and women could be attributed to explained (productivity related) factors, and how much could be only explained by labor market discrimination.

To determine the monetary value that each individual ought to receive in the absence of discrimination in the labor market, Oaxaca and Ranson (2003) discuss several possibilities using the Blinder-Oaxaca decomposition, which we modified to be applied in the quantile decomposition results, as follows. If group B is discriminated against, each individual of this group ought to receive a wage based on the wage equation of group A (non-discriminated). Hence, for each individual i in quantile τ[3]:

$$\hat{Y}_{iB}^{A} = \sum_{k=1}^{K} X_{Bik}\hat{\gamma}_{Ak} \tag{1}$$

where $\hat{Y}_{iB}^{A}$ is the estimated wage for individual i from group B, using the wage equation coefficients for group A. X_{Bik} are k observed characteristics for individual i from group A and $\hat{\gamma}_{Ak}$ represent the estimated coefficients for k variables of group A. Thus, the wage differential predicted for each woman in Group B (discriminated) is given by:

$$e_{iB}^{A} = Y_{Bi} - \hat{Y}_{iB}^{A} \tag{2}$$

where Y_{Bi} is the observed labor income. For Oaxaca and Ranson (2003) the naïve approach is to define the adjustment as predicted by equation (2):

$$A_{Bi}^{(1)} = -\, e_{iB}^{A} \tag{3}$$

where $A_{Bi}^{(1)}$ is the necessary wage adjust for each i, belonging to group B. Thus, if group B has N_B individuals, the aggregated adjustment is:

$$A_{B}^{(1)} = \sum_{i=1}^{N_B} A_{Bi}^{(1)} = \sum_{i=1}^{N_B} -\, e_{iB}^{A} = N_B\hat{D} \tag{4}$$

where $\hat{D}$ is the average wage adjustment for group B, which implies an average adjusted wage for each individual belonging to group B equivalent to:

$$\hat{Y}_{B}^{A} = \bar{Y}_{B} + \hat{D} \tag{5}$$

The methodology corresponds to bringing all individuals to the hyperplane of estimated wages regression for the non-discriminated group. However, errors predicted for the non-discriminated group would cause an asymmetry, as the wage equation estimated is not a perfect predictor of individual wages. In this case, the adjustment would lead to differences in payments not only in the group discriminated against, but also in the reference group.

To correct this asymmetry, Oaxaca and Ranson (2003) proposed an alternative estimation where the predicted error for each individual (on its own wages regression) is incorporated into the adjustment. That is,

[2] For all regression we used Mills' ratio to correct for selective bias in labor market participation.
[3] The quantile indicator (τ) was omitted to simplify the notation.

it is assumed that the portion of individual wages not predicted by the wage equation of each group is due to individual characteristics, unmeasured, and randomly distributed, such as work motivation and innate skills, which remain with the individual even after the adjustment. Therefore, the new adjustment is given by:

$$A_{Bi}^{(2)} = A_{Bi}^{(1)} + e_{iB}^{B} = -e_{iB}^{A} + e_{iB}^{B} = \hat{Y}_{B}^{A} - \hat{Y}_{B}^{B} \tag{6}$$

Thus, the adjustment becomes equivalent to the difference between the predicted earnings for group B, using the equation of group A, minus group B own wages prediction. In aggregate terms:

$$A_{B}^{(2)} = \sum_{i=1}^{N_B} (-e_{iB}^{A} + e_{iB}^{B}) = A_{B}^{(2)} \tag{7}$$

According to the assumptions of the OLS estimator: $-\sum_{i=1}^{N_B} e_{iB}^{A} = 0$; hence, the total adjusting cost for employers is exactly the same, however, the individual adjustment distribution changes. In this case, the non-discriminated adjustment (group A) would be zero, because: $A_{Ai}^{(2)} = \hat{Y}_{A}^{A} - \hat{Y}_{A}^{A} = 0$.

Although the second adjustment proposal solves the asymmetry problem between groups, there is no guarantee that all discriminated individuals maintain or improve their wages. This happens because it is possible for < 0 for discriminated individuals whose wages predicted by the equation of non-discriminated group is lower than the observed wage, which would imply a wage reduction for some individuals of group B. As the authors note, the implementation of such adjustment would not be possible for legal reasons, which forbid wage reduction. To solve the problem, it is necessary to restrict the compensation only to individuals with adjusted salary higher than the observed one, i.e.:

$$A_{Bi}^{(3)} = \phi_{Bi} A_{Bi}^{(2)}$$
$$\phi_{Bi} = \begin{cases} 1 \; se \; A_{Bi}^{(2)} > 0 \\ 0 \; se \; A_{Bi}^{(2)} \leq 0 \end{cases} \tag{8}$$

However, in this case, the total cost is greater than the value predicted by the decomposition model, over-compensating the discriminated group, and burdening the firms more than necessary. Once again, to fix this problem, Oaxaca and Ranson (2003) propose the redistribution of initial adjustment ($A_{B}^{(1)} = A_{B}^{(2)} = N_B \widehat{D}$) according the share of each individual whose salary is below the estimated ($\phi_{Bi} = 1$) in the total positive adjustment ($A_{B}^{(3)}$). Therefore, the participation of each individual discriminated against in the adjustment is:

$$\lambda_{Bi} = \frac{A_{Bi}^{(3)}}{A_{B}^{(3)}} = \frac{\phi_{Bi} A_{Bi}^{(2)}}{A_{B}^{(3)}} \tag{9}$$

such that:

$$0 \leq \lambda_{Bi} \leq 1$$
$$\sum_{i=1}^{N_B} \lambda_{Bi} = 1 \tag{10}$$

The adjustment can be defined as:

$$A_{Bi}^{(4)} = \lambda_{Bi} A_{Bi}^{(2)} \tag{11}$$

All individuals effectively discriminated ($\phi_{Bi} = 1$) receive some wage adjustment, while the total amount of the adjustment (which must be paid by firms) would be exactly the amount of the discrimination coefficient estimated by the wages decomposition.

In this paper, for each income decile it was necessary to define a criterion for an individual i belonging to group B, whose observed wage salary is Y_i, to receive an adjustment of wage ($A_{Bi,\tau}$) corresponding to the prediction for quantile τ. Accordingly, defining κ_t as a quantile for which de decomposition was calculated, such as $\kappa_t = \kappa_1, \dots, \kappa_T$, and when $\kappa_t = \kappa_T$, $q_\tau = 1$; the wage adjustment for each i, located in the τ-th quantile, is represented by:

$$A_{Bi,\tau} = \psi_{Bi,\tau} A_{Bi,\kappa_t}$$
$$\psi_{Bi,\tau} = \begin{cases} A_{Bi,\kappa_1}, & \text{se } \tau \leq \kappa_1 \\ A_{Bi,\kappa_t}, & \text{se } \kappa_{t-1} < \tau < \kappa_t \end{cases} \tag{12}$$

In this way, if the recentered influence function was calculated to each decile of wage distribution, so the individuals, for example, in the tenth percentile should receive the adjustment calculated for the first decile; the workers between the tenth and twentieth percentiles should receive the adjustment calculated for the second decile, and so on.

Consequently, the average adjustment to τ as defined by (11), must be the same as calculated in the wage decomposition for the whole distribution. However, only some share receives this adjustment, and it is not possible to guarantee that the average adjustment is equal to the total predicted for the whole distribution. To make sure that this occurs, a new criterion for adjustment, similar to the ones proposed before, is made:

$$A_{B,\kappa}^{(5)} = \sum_{i=1}^{N_{B,\kappa}} A_{Bi,\kappa}^{(5)} = N_{B,\kappa} \widehat{D}_\kappa \tag{13}$$

where $N_{B,\kappa}$ is the number of individuals in group B who will receive the adjustment calculated for the κ quantile, and $\widehat{D}_\kappa$ is the average adjustment calculated for the κ quantile throughout the distribution. Redefining the equation (9) as the participation of each discriminated individual in the adjustment for the κ quantile:

$$\lambda_{Bi,\kappa} = \frac{A_{Bi,\kappa}^{(3)}}{A_{B,\kappa}^{(3)}} \tag{14}$$

Thus, the received adjustment to each individual in group B, and quantile κ, using the function $\psi_{Bi,\tau}$ drawn up in (12), is:

$$A_{Bi,\kappa}^{(5)} = \lambda_{Bi,\kappa} A_{B,\kappa}^{(5)} = \lambda_{Bi,\kappa} N_{B,\kappa} \widehat{D}_\kappa \tag{15}$$

It is worth mentioning that some individuals may receive a wage adjustment lower than their own merits, because they absorb the deficit of those whose adjustment would be negative.

3.2. Input-Output Model

The input output model is a linear system of equations describing the economic system. The basic equation, according to Miller and Blair (2009), can be expressed as:

$$x = Z + f \tag{16}$$

where x is a vector of total output by industry, Z is the intermediate input matrix that represents the economic flows between industries, and f is the vector of final demand by industry. Then, the technical coefficient matrix is given by:

$$A = Z\hat{x}^{-1} \tag{17}$$

where each element of $A = a_{ij}$ shows the amount industry i product used as intermediate input by industry j. Therefore, the model's solution can be represented as.

$$x = (I - A)^{-1} f \quad (18)$$

where $(I - A)^{-1}$ is the total impact matrix referred to as the Leontief inverse matrix.

In this model, all flows between industries are in monetary terms and prices are fixed at the base year value. However, to estimate a price effect of the wage adjustment, it is possible to change the production cost, that is incorporated in output prices, using the Leontief price model (1941, 1946).[4] Thus, initially, industrial output x is equal to the sum of inputs cost to the value added v components.

$$x' = i'A\hat{x} + v' \quad (19)$$

Post-multiplying equation (19) by $\hat{x}^{-1}$, it follows that:

$$i' = i'A + v'\hat{x}^{-1} \quad (20)$$

Yielding $L = (I - A)^{-1}$ and assuming that the price is equal to the production cost so that $i' = p_0$, the price index for the base year is given by:

$$p = L'v'\hat{x}^{-1} \quad (21)$$

To impose a wage adjustment, a vector, T is defined that is calculated according to value added in this sector as:

$$T = \varphi\hat{v} \quad (22)$$

where φ is the rate of wage adjustment for each sector. Therefore, using $\tau = T\hat{x}^{-1}$, the adjusted prices vector (p^*) can be calculated as:

$$p^* = L'(v\hat{x}^{-1} + \tau)p \quad (23)$$

Following Gemechu *et al*. (2014), if the monetary values of sectoral output are held constant, before and after tax, then the sectoral real output becomes:

$$x^* = (p/p^*)x \quad (24)$$

Therefore, the impact on the price index (π) is given by:

$$\pi = \sum_j p_j^* \alpha_j \quad (25)$$

where α_j is the share which industry j production represents in total output. The government revenue with new tax was estimated as:

$$R = \varphi x^* \quad (26)$$

Assuming households maximize their utilities using a Leontief function, and their income and savings are unchanged, none of each representative household could afford the same basket of goods. Therefore, using price changes derived from the model, it is possible to calculate the change in consumption as a measure of welfare. Formally, household welfare change (Δw_k) for decile k is the following:

$$\Delta w_k = \left(\sum_i c_{ik} p\right) - \left(\sum_i c_{ik} p^*\right) \quad (27)$$

where c_{ik} is the quantity consumed by decile k from industry i.

For the income/consumption effect, equation (18) was used, updated after the price change, and we shocked the final demand the amount of wage adjustment calculated previously.

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[4] It is important to highlight, that, according to Miller and Blair (2009), Ghosh model (1958) produce the same results. For different interpretations of Ghosh and price models, see Dietzenbacher (1997), Oosterhaven (1996) and Mesnard (2009).

4. RESULTS

4.1. Wages Decomposition and Adjustment

Wage decompositions have been estimated by deciles[5] for individuals between 16 and 65 years. The dependent variable, hourly wage logarithm in the main job, was regressed with the following controls: age; age squared; school attendance (dummy); rural and urban region (dummy); years of education (between zero and three years, four and seven, eight and ten, eleven and fourteen, and more than fifteen); occupation type (formal, informal, self-employed and employer); family type (couples with and without children; others); and regional dummies for Federative Unions. All workers employed in the public sector were excluded from the sample.

The aggregate results divided into the proportion explained by observable characteristics and the unexplained share indicate effects similar to those reported in the literature reviewed (Table 1).[6] The decomposition showed that for their observed characteristics, women should receive higher wages than those of men. Nevertheless, women have lower returns to these characteristics increasing the gap in favor of men. Similar results can be seen in Soares (2000); Biderman and Guimarães (2004); Bartalloti (2007); Cambota and Marinho, (2005); Cacciamali *et al.* (2009).

<<insert table 1 here>>

In general, it is possible to highlight three distinct points in the path of wage gap across the distribution (Figure 2): i) a high discrimination in the first deciles suggesting the effect of "sticky floor" observed by Arulampalam *et al* (2007) for Spain and Italy, which can be explained by the informality at the beginning of the income distribution favoring discrimination; ii) the change of direction around the fourth decile, may be related to the minimum wage, which equals the income of workers around the value set by the government and iii) increased discrimination from the fifth decile suggesting the effect of "glass ceiling," which reveals the existence of barriers to entry of blacks to positions of higher pay.

Following the methodology proposed by Oaxaca and Ranson (2003) (presented in section 3.1) wage adjustments were calculated from the recentered regressions. Thus, it was possible to simulate the wage for women if their payments were obtained based on the remuneration of characteristics for men for each individual. The necessary adjustment estimated (as adjust five) industry were used as for input-output simulations.

<<insert figure 2 here>>

4.1. Input-Output Simulations

According to the exposition in section 3.2, two simulations were conducted using the input-output model. The first simulation accounts for the price effect, i.e., the effect of rising production costs through women's wages increases. On the other hand, the second simulation focuses on the income effect, generated by increasing consumption for every decile of income in proportion to the wage adjustment. Sectorial results for both simulations can be found in Table 2.

The first simulation operates basically as the following: i) the adjustment was calculated at the individual level, ii) the change in sectorial labor cost depends on the total adjustment owed to all women

[5] It was estimated regressions at the points: 0.10; 0.20; 0.30; 0.40; 0.50; 0.60; 0.70. 0.80; 0.90; and 0.99 of the wage distribution.

[6] Complete results can be obtained by contacting the authors.

working in that sector; iii) the increase in wages is incorporated as a rise in production cost, that causes expanding prices; iv) using Leontief price model assumptions, if the amount of money in the economy is the same, all households need to adjust their consumption and the production falls; v) employment follows production.

In the second simulation, it was assumed that the economy changed due to the first shock; however, now, women wages are higher and there is a consumption growth proportion to the wage adjustment. Therefore, there are only three developments: i) consumption increases production; ii) employment follows production; iii) as a model assumption, prices do not change.

<<insert table 2 here>>

The consumption results for both simulations are the most important in terms of policy (Table 3). For the first three deciles, the income effect is surpassed by the price effect. For these households, the rise in prices overcomes the benefit of ending female discrimination. The same happens for the last decile, but not between deciles four and nine, thus guarantying a positive welfare effect for the economy as a whole. Table 4 summarizes the results for aggregated variables. It shows how the total effect over aggregated production is positive, even if not for all sectors. The same happens to welfare. The overall effect is positive despite negative effects for some households. The negative results can be explained by both the rise in prices and the employment losses.

<<insert tables 3 and 4 here>>

5. FINAL REMARKS

Discrimination in the labor market imposes a cost on society by penalizing individuals discriminated against and by reducing the potential output, as suggested by D'Amico (1987). This paper seeks to address these issues for the Brazilian economy, through the integration of an econometric model of wage decomposition and input-output simulations. The first model was used to calculate how much women wages should increase so that there is no discrimination in the labor market. The input-output model was used to simulate the effect of such a change for the role economy.

The simulation results indicate that the income effect generated through consumption overcomes the price effect for the economy as a whole, due to the wage rising in terms of production and welfare but not in terms of employment. Nonetheless, the results are very heterogeneous across sectors and households.

It is worth noting that the results here have several underlying and restrictive assumptions; however, they constitute what would be the first effect of eliminating gender discrimination in Brazilian labor market, and they can yield some light on short-run effects. In the long-run, technological changes can be expected to modify the way sectors combine inputs and generated output, as well as a direct effect over women labor supply. As the expected wages for women grows up, more women's labor supply should grow, reinforcing the positive effect over the income, not to mention the pure effect of been able to work with fair wages.

Another important point to be highlighted is that the simulation was performed only considering discrimination in the labor market, i.e., given the characteristics individual as fixed. However, as pointed out by several studies (Cain, 1984; Altonji and Blank, 1999; Blank *et al*., 2004; Vemman, 2010; Lang and Lehmann, 2011), these characteristics are influenced by pre-market features, such as investment in education and qualification, experience and own decision to enter or not in the labor market, issues that have not been addressed in this work. These and other topics are intended to be part of future developments.

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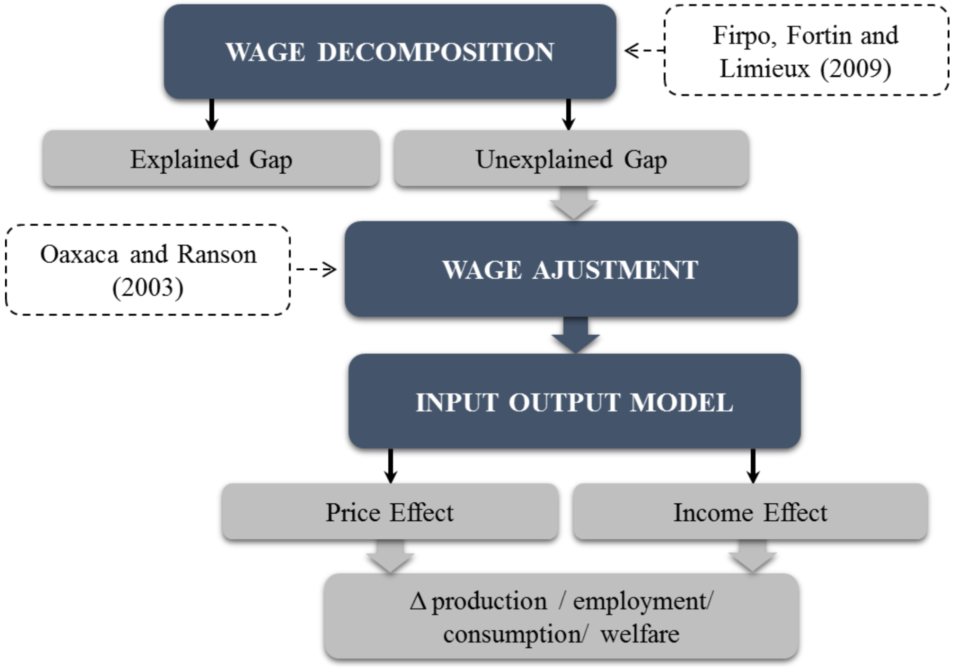
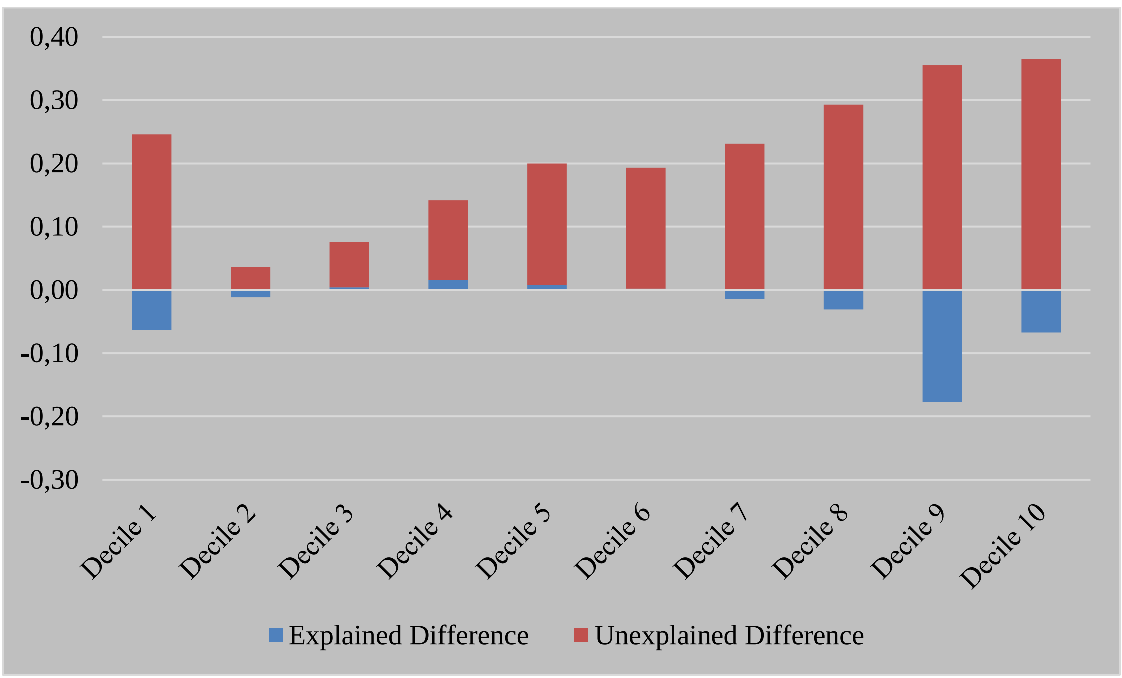
Figures:

Figure 1 – Linkage between Wage Decomposition and Input-Output Simulations



Source: Prepared by the authors

Figure 2 – Wage decomposition results in percentage of explained and unexplained differential by decile



Source: Prepared by the authors

Tables:

Table 1 – Wage decomposition results

	Hourly log wage for men (1)	Hourly log wage for women (2)	Difference (1) – (2)	Explained Difference	Unexplained Difference
Decile 1	1.140***	0.957***	0.182***	-0.0633***	0.246***
	(0.000134)	(0.000645)	(0.000658)	(0.000271)	(0.000665)
Decile 2	1.359***	1.335***	0.0244***	-0.0118***	0.0362***
	(8.60e-05)	(9.67e-05)	(0.000129)	(0.000209)	(0.000223)
Decile 3	1.525***	1.448***	0.0761***	0.00403***	0.0720***
	(0.000129)	(5.04e-05)	(0.000139)	(0.000294)	(0.000299)
Decile 4	1.690***	1.549***	0.141***	0.0154***	0.126***
	(0.000197)	(0.000129)	(0.000235)	(0.000421)	(0.000433)
Decile 5	1.863***	1.664***	0.200***	0.00752***	0.192***
	(6.81e-05)	(0.000146)	(0.000161)	(0.000141)	(0.000188)
Decile 6	2.033***	1.839***	0.193***	0.00202***	0.191***
	(8.75e-05)	(7.96e-05)	(0.000118)	(0.000174)	(0.000185)
Decile 7	2.239***	2.022***	0.216***	-0.0146***	0.231***
	(0.000128)	(0.000119)	(0.000175)	(0.000237)	(0.000254)
Decile 8	2.531***	2.270***	0.262***	-0.0309***	0.293***
	(9.59e-05)	(0.000447)	(0.000457)	(0.000170)	(0.000447)
Decile 9	2.970***	2.792***	0.178***	-0.177***	0.355***
	(0.000464)	(0.000630)	(0.000782)	(0.000762)	(0.000965)
Decile 10	4.744***	4.446***	0.297***	-0.0673***	0.365***
	(0.00137)	(0.000869)	(0.00162)	(0.00232)	(0.00286)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Prepared by the authors

Table 2 – Input-Output Simulation Results by Sector

Sector*	Simulation 1 - Price effect			Simulation 2 - Income effect		
	Prices (% change)	Production (% change)	Employment (number of jobs)	Prices (% change)	Production (% change)	Employment (number of jobs)
1	1.47	-1.45	-88,190	0.00	3.46	210,238
2	2.00	-1.96	-126,048	0.00	4.44	284,942
3	2.30	-2.25	-21,221	0.00	4.45	41,915
4	1.03	-1.02	-1,502	0.00	1.43	2,093
5	0.81	-0.80	-566	0.00	3.04	2,140
6	0.62	-0.62	-346	0.00	0.25	141
7	1.53	-1.51	-529	0.00	1.03	360
8	2.82	-2.74	-18,550	0.00	5.06	34,245
9	1.54	-1.52	-3,530	0.00	3.00	6,984
10	2.63	-2.56	-32,859	0.00	4.95	63,609
11	1.59	-1.56	-2,819	0.00	6.08	10,954
12	3.66	-3.53	-677	0.00	3.59	689
13	8.89	-8.16	-54,134	0.00	5.45	36,170
14	9.11	-8.35	-151,242	0.00	6.03	109,314
15	4.62	-4.42	-24,466	0.00	5.52	30,565
16	2.79	-2.71	-11,525	0.00	2.63	11,169
17	1.95	-1.91	-3,928	0.00	3.26	6,713
18	2.13	-2.09	-4,349	0.00	3.95	8,236
19	1.23	-1.22	-318	0.00	4.10	1,072
20	1.92	-1.88	-1,746	0.00	4.03	3,738
21	1.17	-1.16	-1,124	0.00	2.77	2,685
22	1.37	-1.36	-1,366	0.00	2.55	2,571
23	2.70	-2.63	-3,962	0.00	4.84	7,289
24	1.78	-1.75	-1,842	0.00	4.44	4,684
25	2.58	-2.52	-12,756	0.00	3.27	16,574
26	1.52	-1.49	-10,363	0.00	1.22	8,454
27	0.99	-0.98	-1,447	0.00	1.39	2,047
28	1.46	-1.44	-1,688	0.00	1.56	1,835
29	1.41	-1.39	-10,955	0.00	2.30	18,184
30	1.77	-1.74	-3,223	0.00	3.18	5,876
31	1.88	-1.84	-4,898	0.00	2.67	7,113
32	1.62	-1.59	-7,951	0.00	0.59	2,936
33	1.56	-1.54	-3,224	0.00	2.83	5,922
34	1.83	-1.80	-6,230	0.00	2.27	7,874
35	2.54	-2.48	-3,323	0.00	1.65	2,204
36	2.64	-2.57	-21,453	0.00	4.04	33,704
37	1.21	-1.19	-6,636	0.00	2.28	12,687
38	0.92	-0.91	-1,336	0.00	4.57	6,726
39	1.71	-1.68	-10,217	0.00	3.74	22,701
40	0.85	-0.84	-74,135	0.00	0.18	15,480
41	1.34	-1.32	-37,366	0.00	4.01	113,477
42	3.41	-3.30	-519,418	0.00	4.05	638,916
43	1.26	-1.24	-45,671	0.00	4.18	153,688

(continues on the next page)

(Table 2 – Input-Output Simulation Results)

Sector	Simulation 1 - Price effect			Simulation 2 - Income effect		
	Production (% change)	Prices (% change)	Employment (number of jobs)	Prices (% change)	Production (% change)	Employment (number of jobs)
44	2.16	-2.11	-1,288	0.00	3.00	1,825
45	4.72	-4.51	-3,045	0.00	3.61	2,439
46	1.51	-1.49	-12,375	0.00	3.76	31,285
47	3.41	-3.30	-13,644	0.00	3.15	13,026
48	4.60	-4.40	-204,706	0.00	5.68	264,586
49	3.54	-3.42	-5,742	0.00	4.75	7,966
50	2.43	-2.37	-4,313	0.00	4.12	7,484
51	1.95	-1.91	-4,777	0.00	5.38	13,462
52	2.06	-2.01	-14,140	0.00	1.60	11,226
53	3.58	-3.46	-38,871	0.00	4.58	51,475
54	0.23	-0.23	-904	0.00	5.96	23,338
55	3.87	-3.73	-60,406	0.00	3.47	56,234
56	3.47	-3.36	-19,793	0.00	1.66	9,764
57	4.13	-3.97	-20,522	0.00	3.80	19,625
58	2.24	-2.19	-7,353	0.00	3.02	10,132
59	5.34	-5.07	-207,178	0.00	2.69	110,038
60	0.93	-0.92	-7,832	0.00	2.84	24,159
61	4.80	-4.58	-251,073	0.00	0.21	11,310
62	8.90	-8.17	-349,012	0.00	0.04	1,693
63	10.51	-9.51	-220,767	0.00	6.03	140,094
64	6.34	-5.96	-109,680	0.00	0.07	1,294
65	5.54	-5.25	-136,644	0.00	4.69	122,129
66	6.08	-5.73	-53,164	0.00	4.23	39,177
67	6.39	-6.00	-238,301	0.00	4.06	161,272
68	11.31	-10.16	-667,806	0.00	6.41	421,424

*Sectorial names can be found in Annex 1.

Source: Prepared by the authors

Table 3 – Input-Output Simulation Results by Decile

	Initial Consumption (BR$)	Simulation 1 - Price effect	Simulation 2 - Income effect	Total
Decile 1	64,032.19	-1,580.78	1,451.16	-129.62
Decile 2	82,708.60	-2,098.86	1,474.98	-623.88
Decile 3	98,797.43	-2,596.04	2,283.05	-312.99
Decile 4	113,944.09	-3,051.55	3,302.34	250.79
Decile 5	138,811.42	-3,858.31	4,502.10	643.79
Decile 6	170,131.59	-4,759.55	5,339.18	579.63
Decile 7	211,435.99	-6,163.38	8,119.61	1,956.22
Decile 8	274,868.33	-8,257.10	11,328.93	3,071.83
Decile 9	402,624.86	-12,192.06	18,115.83	5,923.77
Decile 10	1,231,657.01	-39,627.70	31,144.27	-8,483.43
Total	2,789,011.50	-84,185.33	87,061.44	2,876.11

Source: Prepared by the authors

Table 4 – Aggregated Input-Output Simulation Results

	Simulation 1 - Price effect	Simulation 2 - Income effect	Total
Production (% change)	-2.77%	3.22%	0.36%
Employment (number of jobs)	-3,992,464	3,515,372	-477,092
GPI (% change)	2.90%	0.00%	2.90%
Welfare (BR$)	- 84,185.33	87,061.44	2,876.11

Source: Prepared by the authors

Annex 1 – Sectors description

Sector Code	Description
1	Agriculture, forestry, logging
2	Livestock and fisheries
3	Oil and natural gas
4	Other mining and quarrying
5	Food and drinks
6	Smoke products
7	Food & Beverage Outlets
8	Clothing articles and accessories
9	Leather and shoe artifacts
10	Wood Products - exclusive furniture
11	Pulp and paper products
12	Newspapers, magazines, nightclubs
13	Oil refining and coke
14	Alcohol
15	Chemicals
16	Perfumery, hygiene and cleaning
17	Rubber & Plastics
18	Non-metallic mineral products
19	Basic Metallurgy
20	Metal products - exclusive machinery and equipment
21	Machinery and equipment, comprehensive maintenance and repairs
22	Home appliances
23	Office machines and computer equipment
24	Electrical machinery, apparatus and equipment
25	Electronic material and communications equipment
26	Medical apparatus and instruments
27	Vehicles, trailers and buses
28	Parts and accessories for motor vehicles
29	Other transportation equipment
30	Furniture and decorations, garden
31	Electricity and gas, water, sewage and urban cleaning
32	Construction
33	Trade
34	Transportation, paper and packaging
35	Information services
36	Financial intermediation and insurance
37	Real estate services and rentals
38	Maintenance and repair services
39	Accommodation and food services
40	Business services
41	Merchant education
42	Health and Safety
43	Other services
44	Public education
45	Public health
46	Public administration and social security