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THE EVOLUTION OF GENDER AND RACIAL OCCUPATIONAL  
SEGREGATION ACROSS FORMAL AND NON-FORMAL LABOR  
MARKETS IN BRAZIL, 1987 TO 2006

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This study provides a unique analysis of the evolution of gender and racial occupational segregation in Brazil covering the period from 1987 to 2006. Employing a newly harmonized occupational classification, it provides new insights into the nature and evolution of occupational segregation and on the forces driving these changes over this period of time. Three major findings emerge. First, gender segregation is always greater than racial segregation, but the latter has been more persistent over time. Second, segregation has declined mainly in the formal labor market. Third, this decline has been mainly driven by changes in gender and racial composition within occupations.

**JEL Codes:** J71, O17

**Keywords:** Brazil, gender, informality, race, occupational segregation

## 1. INTRODUCTION

Occupational segregation is an important theme in the labor economics literature and has been the subject of many theoretical and empirical studies over several decades (Albelda, 1986; King, 1992; Charles and Grusky, 1995; Anker, 1997; Reardon and Firebaugh, 2002; Fryer, 2010). However, despite its centrality to any understanding of labor market outcomes, studies of occupational segregation have been very rare for developing countries. One of the reasons for the neglect of this issue for developing countries has been an absence of sufficiently detailed and reliable data over time. This study seeks to redress this lacuna in the existing literature with a focus on Brazil, and makes three main contributions. First, it assesses the magnitude and the evolution of occupational segregation by both gender and race, thus addressing an important omission in the existing research and highlighting divergent trends across these population sub-groups.<sup>1</sup> Second, it disaggregates the analysis between the formal, informal, and self-employed sectors, shedding light on important differences across the formal and non-formal sectors. Finally, it explores the drivers of changes in occupational segregation over time by applying a decomposition technique originally developed by Deutsch *et al.* (2009).

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<sup>1</sup>For the sake of simplicity we employ the commonly recognized term “race” to denote skin tone. However the term “skin tone” is arguably more accurate as the Brazilian population is generally held not to be classifiable into ethnicities (Wood, 1991; Lovell and Wood, 1998; Telles and Lim, 1998).

Similar to most developing countries, the analysis of occupational segregation in Brazil has been constrained by data availability. A revision to the classification of occupational codes used in the Brazilian household survey, the *Pesquisa Nacional por Amostra do Domicilio* (PNAD), after 2001 prevented a consistent comparison over time. This study overcomes this constraint by employing a newly harmonized reclassification of the occupational codes provided by Salardi (2013), which covers the entire period 1987–2006. This makes it possible to compute levels of both gender and racial occupational segregation using a detailed occupational classification over a longer time period than has previously been possible. This is of particular interest because it allows changes in occupational segregation during a period in which Brazilian labor markets experienced several institutional and macroeconomic shocks to be evaluated. These include the establishment of a new Constitution in 1988, structural economic reforms beginning in the early 1990s, and negative external shocks at the turn of the century. It is also a period in which the government introduced a range of anti-discrimination legislation (ADL) aimed at reducing discrimination in the labor market and, by extension, occupational segregation.

The analysis reveals that while gender segregation is significantly greater than racial segregation, it has fallen more rapidly between 1987 and 2006. By contrast, racial segregation is lower in absolute terms, but has been highly persistent over time. Racial segregation may, moreover, be a more troubling trend because it is relatively difficult to explain by reference to differences in psychological attributes alone.<sup>2</sup> The implementation of the Shapley decomposition proposed by Deutsch *et al.* (2009) offers further insight, as we find that the decline in both gender and race based segregation is primarily the result of the more homogenous representation of women and non-whites within occupations. It is sometimes suggested that declining occupational segregation may simply be the result of increasing labor market participation by women and non-whites, and thus not reflective of broader changes in labor market outcomes (Semyonov and Jones, 1999). However, we find that this simple explanation does not hold. The entry of women and non-whites into the labor market has, if anything, increased segregation, as many new entrants to the labor force have joined traditionally more segregated occupations, which have increased in size over time. The aggregate decline in segregation is thus driven by general improvements in the composition within individual occupations, which represents a more “real” and encouraging development.

Disaggregating the analysis in terms of formal, informal, and self-employed sectors yields additional insights because it provides an entry point for exploring

<sup>2</sup>A growing literature has highlighted the fact that gender and racial discrimination may be explained not only by neoclassical models of discrimination, information-based theories, or institutional and labor market segmentation theories. As argued by Bertrand (2011), gender discrimination might also be explained by gender differences in psychological attributes (such as risk preferences as well as attitudes toward competition and negotiation) and by the existence of social norms, and the construction of social identities, that lead to labor market discrimination. The role of social norms and social identities may apply to both gender and racial segregation. By contrast, the role of differences in psychological attributes in explaining segregation has been applied primarily to explaining gender segregation, as there is little basis for applying these same assumptions to racial categories.

the potential importance of ADL in limiting segregation. The formal sector provides the framework for regulated labor markets to function given it is in the formal sector that ADL is anticipated to have the greater impact. As a consequence, we would expect different outcomes in terms of gender and racial differentials across the formal, informal, and self-employed sectors. Consistent with these expectations, we find a more rapid decline in both gender and racial segregation in the formal sector, while racial segregation in particular has experienced a negligible decline in the informal sector. We further find that in the informal sector the entry of disadvantaged groups into the labor market has been particularly concentrated in the already segregated occupations. While it is important to stress that this study does not establish causal relationships between institutional reforms and segregation, the analysis does offer insights into possible directions for future research.

## 2. BACKGROUND

Empirical studies of occupational segregation tend to analyze the phenomenon by employing tools drawn from the study of income inequality in order to construct new measures of segregation and to assess the extent of segregation and its trend over time. Studies measuring the degree of occupational segregation in individual countries have been surprisingly uncommon, and the available literature generally focuses on gender rather than racial segregation. A careful review of the literature has uncovered 30 studies that focus exclusively on measuring country-specific occupational segregation, of which 27 look at gender and 10 at racial segregation. A full list of these sources is presented in Appendix 1. In addition to these individual country studies, a few exploit a cross-country perspective. Blackburn *et al.* (1993), Charles and Grusky (1995), and Deutsch and Silber (2005) provide cross-country studies focusing on subsets of OECD countries, while Melkas and Anker (1997) provide a comparison across the set of Nordic countries. Semyonov and Jones (1999) analyze data from 56 nations to study both occupational (horizontal) segregation and hierarchical inequality. Most notably, little of the empirical work examines segregation across developing countries, with the exception of Anker *et al.* (2003), who analyze cross-country variation in occupational segregation in a sample comprising both developed and developing countries, Deutsch *et al.* (2005), who explore gender segregation in Costa Rica, Ecuador, and Uruguay, and finally Gradín (2012), who analyzes the extent of occupational segregation among Afro-Latinos in various Latin American countries, including Brazil, Costa Rica, Cuba, Ecuador, and Puerto Rico.

Focusing specifically on Brazil, the theoretical and empirical research that examines wage discrimination is extensive (Soares, 2000; Arabsheibani *et al.*, 2003; Arcand and D'Hombres, 2004; Arias *et al.*, 2004; Silva *et al.*, 2006), but work investigating occupational segregation has been limited. King (2009) provides the most comprehensive empirical study of Brazilian occupational segregation along gender and racial lines over the period 1989 to 2001. The author finds that occupational segregation by gender is double that of race. In addition, while the findings reveal an overall decline in segregation, she finds that racial discrimination

has not declined among younger people, men, and the most educated. The study confirms previous findings from Oliveira (2001), who reports a three percentage point decline in gender occupational segregation between 1987 and 1999. Oliveira (2001) in turn finds that this trend was driven primarily by increased female participation in the labor market, while female workers remained heavily concentrated in certain jobs. Alongside King (2009) additional research exploring occupational equality along racial lines has been uncommon, with Gradín (2012) offering an exception with one of the very few empirical studies of occupational segregation among Afro-descendants in Brazil. The author focuses on measuring the extent to which racial segregation can be explained by observed factors such as education, migration status, age, and location, as opposed to unexplained segregation. The study reports that in Brazil occupational segregation is primarily explained by lower educational levels among African descendants, thus highlighting the importance of pre-labor market inequalities. The absence of research on racial inequality across occupations is striking given the existence of a long-standing sociological literature highlighting the importance of racial inequality in the country (Lovell, 1994, 2000; Telles, 2006).

An important limitation of the already small literature on occupational segregation is that none of these studies distinguish between formal and non-formal sectors. This is a potentially important oversight. First, there are good reasons why patterns may differ across the formal, informal and self-employed sectors: the informal and self-employed sectors may offer a more flexible alternative for economic activity and, as such, different trends between the formal and non-formal sectors may reflect the impact of labor market regulations in shaping patterns of segregation. Second, differences between the formal and non-formal sectors may have important welfare implications, as those in the non-formal sector frequently face greater risk exposure given that they do not benefit from social protection or regulation.

There is a longstanding literature exploring the role of the informal sector within the Brazilian economy. A part of this literature has focused on exploring competing definitions of informality. Much of this debate has revolved around two alternative views of informality, highlighted by Gasparini and Tornarolli (2007). The first definition focuses on the productive aspects of the activity and defines informal activities as small-scale, family-based, and low-technology activities. The second focuses primarily on the legalistic and social protection aspects of informality. They conclude that the latter is possibly a more appropriate definition for informality in the South American context, and most Brazilian research has correspondingly focused on such legal definitions of informality. This has included studies of Brazilian informality focused on wage workers without labor contracts, self-employed individuals, employers earning up to a certain portion of the minimum wage, unpaid family workers, and domestic service workers (Jatobá, 1987; Carneiro, 1997). Other studies have adopted a definition of informality based on the payment of social security contributions (Cacciamali, 1988; Telles, 1992).

Despite these definitional challenges and uncertainties, most empirical studies have defined informal workers as those without signed work cards, the *carteira de trabalho* (Soares, 2004; Ulyssea, 2005). However, this apparent consensus may

conceal some definitional difficulties. In a more recent paper, Henley *et al.* (2009) compare three different definitions of informality centered on: (i) contract status, based on the possession of a signed work card; (ii) social security status, based on contributions to a social security institution; and (iii) formal sector activity, based on employment within a firm with more than five employees. They find that only 40 percent of cases are classified as informal across all three definitions of informality.

Notwithstanding differences in definitions, there is consensus that the Brazilian informal market is sizeable. Carneiro (1997) reports that in 1990 about one-half of the economically active population was employed in informal activities. According to Urani (1996), approximately 49 percent of workers possessed a *carteira de trabalho* in 1995. Soares (2004) claims that in 1999 only 14 million out of 36 million private sector workers were in the formal sector. There is greater uncertainty about trends over time in the size of the informal sector. Bosch *et al.* (2007) estimate that the informal private sector in urban areas increased by 10 percent during the 1990s. However, Ramos and Ferreira (2005) emphasize that this increase in informality in Brazil depends heavily on restricting the analysis to metropolitan areas, with most of the increase occurring in the manufacturing sector. However, despite these varied efforts to explore the size of the informal sector, there has been limited attention to different experiences by gender and race. Ulyssea (2005) notes that while women are identified as being overrepresented within the informal labor force in all studies, racial issues are ignored in almost all of the literature on Brazilian informality.<sup>3</sup> The most notable exception is Telles (1992), who highlighted the tendency to ignore gender and racial issues in the literature on Brazilian informality. The author found that female occupational opportunities in the formal sector were constrained by both education and race, making less educated women and non-white women more likely to participate in the informal sector. This, the paper argued, was reflected in the fact that female dominated occupations that required a low level of education were more likely to be informal when compared to male dominated occupations that required similar levels of education. These trends have been broadly consistent over time.

The growing interest in the informal sector has included an increased recognition that the formal and informal sectors are interconnected (Cacciamali, 1982, 1983). Bosch *et al.* (2007) confirm the conclusions of a model developed by Fiess *et al.* (2008) which suggests that the informal sector should not be considered inferior to the formal sector and can be understood as an attractive alternative for more flexible and unregulated business opportunities—though frequently at the cost of lower wages and benefits, and potentially greater insecurity. They find that both formal and informal labor markets are highly pro-cyclical and strictly inter-related: most transitions from the formal to the informal sector occur *within particular industries*, implying that the increase in informality is not widely attributable to structural changes in different economic sectors (Ramos and Ferreira,

<sup>3</sup>Abramo (2004) reports that in 2001, 71.2 percent of white women and 76.2 percent of non-white women who engaged in domestic service work did not possess a work card. This heavy representation of non-white women in informal domestic service work is thus an important indicator of the potential connections between race, gender, and informality.

2005). This view has been echoed by Maloney (1999, 2004), who rejects the view of the informal economy as an anti-cyclical “shock absorber” for the formal economy, and the evidence adduced suggests a more positive view of informal markets, which may contribute to minimizing social instability during economic hardship and may even offer employment opportunities outside the influence of government regulation. For instance, in his study, Carneiro (1997) argues that the growth of the Brazilian informal sector may reflect the role of excessive intervention by the government.

Finally, underlying the growing recognition of the interconnected nature of the formal and informal economies is the notion that the relative absence of regulation may be an important motivation for operating in the informal sector in Brazil. Early research by Paes de Barros and Corseuil (2004) explored the impact of labor market regulations and found no evidence of any effect on the extent of informality; they concluded that changes in labor market outcomes can be attributed primarily to macroeconomic developments in the economy. By contrast, Bosch *et al.* (2007) have more recently explored several factors, including trade liberalization and rigidities arising from the Constitutional reforms, which may explain the expansion of the informal sector in certain areas over the two decades. They conclude that trade liberalization has had a small effect, while institutional reforms affecting the labor market have provided the main impetus. There is thus at least some evidence that labor market regulations have shaped patterns of formality and informality in recent decades in Brazil—thus suggesting that patterns of occupational segregation in these two sectors may similarly be shaped by such regulation.

### 3. MEASURING OCCUPATIONAL SEGREGATION OVER TIME

We begin the analysis by measuring the evolution of occupational segregation over time. The discussion proceeds in four parts: a discussion of the data, presentation of the methods and core results, a comparison with previous results, and a series of robustness checks.

#### 3.1. Data

The data are drawn from the Brazilian national household survey (PNAD) over the period from 1987 to 2006, with the start date reflecting the year in which the PNAD dataset reintroduced questions about race.<sup>4</sup> While most studies of Brazilian occupational segregation and other labor market outcomes are based on the PNAD, these studies are plagued by the existence of a major break in the data on occupations, owing to a radical change in the way that occupations have been classified since 2001. The result is that it has been impossible to conduct studies examining the evolution of occupational segregation in Brazil over a protracted

<sup>4</sup>The most plausible alternatives are the *Pesquisa de Padrões de Vida* (PPV), the *Pesquisa Mensal de Emprego* (PME), the Census, and the *Relação Anual de Informações Sociais* (RAIS). However, for our purposes the PNAD provides the best combination of detailed labor market information, including information on the non-formal sectors, and geographic and temporal coverage.

period of time. Two studies employ the classification of occupations proposed by the national household survey, but both are restricted to periods prior to the reclassification of the codes in 2002 (Oliveira, 2001; Machado *et al.*, 2003). In order to overcome this problem, we adopt the newly harmonized reclassification of the PNAD occupational codes proposed by Salardi (2013), which allows for the analysis of a consistent set of occupational codes over the two decades of interest.

The newly harmonized reclassification contains 83 occupational codes at the 3-digit level, 25 at the 2-digit level, and 9 at the 1-digit level. It includes all of the occupations that feature in the public sector, and excludes only the armed forces and two categories of poorly-defined occupations. This reclassification of Brazilian occupational codes is consistent over time and compatible with international standards. It thus offers the basis for more detailed analysis of occupational structure and segregation over a protracted period of time than has previously been possible for Brazil. The construction of this reclassification has involved a two-stage process: first, aggregating multiple PNAD occupational codes into a single occupational code from the international classification; and second, checking earnings and educational outcomes within each aggregated category in order to detect possible mismatches.<sup>5</sup> Key to understanding the challenges associated with this process is the fact that this reclassification involves transforming the more profession-based Brazilian classification system, CBO-94, into the more skill-oriented international system, ISCO-08 (Muendler *et al.*, 2004).

Given this data, we then draw on the literature in categorizing workers across the formal and non-formal sectors. Although some studies focus only on private sector employees, we focus on the entire labor market in order to capture broad trends. While the formal sector includes private employees and domestic workers with signed work cards (*carteira de trabalho*), the “non-formal” sector denotes two separate groups: (i) the informal sectors, which account for private employees and domestic workers without a work card; and (ii) the self-employed sector, though we account for possible difference between these two groups by distinguishing between them throughout the analysis (Maloney, 2004; Almeida and Carneiro, 2007). The treatment of employers poses particular challenges given the difficulty of establishing their formal status. Bosch *et al.* (2007) adopt the ILO definition, which treats employers with less than five employees as being in the informal sector. However, this approach is problematic to implement in practice, as the threshold varies from country to country (see the discussion in Bosch *et al.*, 2007), information on the number of employees is often missing, and some small firm employers are formal according to other metrics, such as the payment of social contributions. The analysis here thus excludes employers. Finally, throughout the core analysis we exclude workers who do not report any wages, though we revisit the implications of this choice in the robustness checks reported below.

Based on this classification of workers between the formal and non-formal sectors, we find that the non-formal sector (i.e., the informal and self-employed sectors) covers more than half of the entire sample across all 20 years, with the

<sup>5</sup>Additional information about the construction of the classification is available from the author upon request.

distribution of workers across the three sectors relatively constant over time, in line with previous research by Ramos and Ferreira (2005). Both women and non-whites have remained overrepresented in the informal sector over time, with non-whites comprising the majority within the informal sector throughout the period under study.<sup>6</sup> Notably, female entry into the labor force has had strong racial dimensions, with white women primarily joining the formal sector and non-white women joining the formal and informal sectors in relatively equal proportion. There are thus important demographic differences across the two sectors. However, the range of occupations and the overall occupational structure are very similar between the formal and informal sectors. This is consistent with the work of Bosch *et al.* (2007), who reveal that the formal and informal sectors are closely interrelated, with most transitions from the formal to the informal sector occurring within the same broadly defined occupational groups.

### 3.2. Methods and Core Results

The analysis exploits the Duncan Index of segregation. The Duncan Index, or dissimilarity index (Duncan and Duncan, 1955), is one of the most widely used measures of segregation and is given by the formula:

$$(1) \quad I_D = \frac{1}{2} \sum_{i=1}^n \left| \frac{F_i}{F} - \frac{M_i}{M} \right| \text{ with } i = 1, 2, \dots, n,$$

where  $F_i$  and  $M_i$  are the number of female and male workers in the  $i$ -th occupation, and  $F$  and  $M$  are the total number of women and men in the labor force. The formulas reported refer to gender segregation; for racial segregation  $F$  and  $F_i$  have to be redefined for non-white workers and  $M$  and  $M_i$  for white ones. The index is generally interpreted as measuring the proportion of the female workforce that would be required to shift between occupations in order to equalize female and male representation across occupations. The main weakness is that redistributing the female workforce in order to achieve zero segregation would inevitably result in a change in the occupational structure. Watts (1998) claims that the Duncan Index fails to show occupation invariance, but it is invariant to the gender composition of the labor force. Despite the popularity of the Duncan Index, several other measures of occupational segregation have been proposed in the literature in an effort to address criticisms faced by the Duncan Index. For the purpose of this study, an alternative set of segregation measures are also employed as robustness checks in the following sub-section.

Figure 1 presents the evolution of gender and racial occupational segregation over time across the formal, informal, and self-employed sectors as measured by the Duncan dissimilarity Index, while the values for only five years at regular intervals (namely 1987, 1992, 1997, 2002, and 2006) are selected and reported in Table A1 of Appendix 2. The confidence intervals are computed using the bootstrap method, which estimates the distribution of the segregation measure by

<sup>6</sup>In 1987, women comprised 34.15 percent of the formal sector and 42.7 percent of the informal sector, while by 2006 these percentages had increased to 42.69 and 47.75 percent, respectively. Similarly, in 1987 non-whites comprised 40.16 percent of the formal sector and 54.25 percent of the informal sector, while in 2006 the percentages were 47.73 and 61.02 percent respectively.

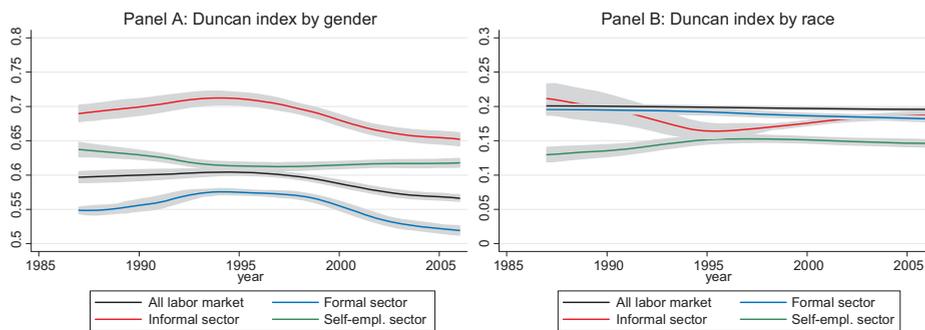


Figure 1. Evolution of Occupational Segregation Over Time

Source: Author’s computations using PNAD from 1987 to 2006. 1991, 1994, and 2001 are missing years. The projections are done using the local polynomial smooth plots with confidence intervals.

resampling with replacement 500 times in order to create multiple estimates of the statistics of interest (Efron and Tibshirani, 1991, 1993). These distributions are then used to construct the lower (2.5 percent) and upper (97.5 percent) bounds around the original points (Boisso *et al.*, 1994).

Gender based occupational segregation is defined in terms of differences in the distribution of women and men across occupations, while race based segregation is defined in terms of non-white and white workers. The term “non-white” includes all individuals classified with a skin tone different from white, namely black (*pretos*) and brown (*pardos*, which includes *mulatos*, *cablocos*, *cafuzos*, *mamelucos*, and *mestiços*).<sup>7</sup> All indices of segregation have been computed using the harmonized 3-digit occupational classification proposed by Salardi (2013).

We find that gender segregation is always considerably higher than racial segregation. In 2006 the Duncan Index between female and male workers was 0.565, which is much greater than the Duncan Index of 0.191 for race. This means that in 2006 more than half of female workers and one fifth of non-white workers would have needed to be reallocated in order to equalize representation across occupations.

Although gender segregation is more severe, over time the situation has improved more rapidly for women than for non-white workers. Gender segregation decreased by 6.6 percent between 1987 and 2006. We notice an initial increase in segregation at the beginning of the 1990s, but this increase is negligible and not always well determined statistically. We subsequently see a relatively rapid, and statistically significant, decline in gender segregation from 1995 to 2006. In contrast, racial segregation declined by 4 percent between 1987 and 2006, while these improvements have been relatively consistent over time. There is thus no evidence of the rapid gains that are apparent in looking at gender segregation.

<sup>7</sup>The actual existence of a “color continuum” makes classifications ambiguous and subjective. For instance, there is evidence that the racial classifications adopted by Brazilians tend to be influenced by their socio-economic conditions (Wood, 1991; Lovell and Wood, 1998; Telles and Lim, 1998).

This sharp decline in gender based occupational segregation in Brazil is consistent with earlier findings reported by Tzannatos (1999), who found that in developing countries gender differentials in employment and pay have been narrowing even faster than was the case in developed countries during the 1960 and 1970s, when they were experiencing rapid labor market changes (Watts, 1998; Baunach, 2002).

When we disaggregate the results across the formal and non-formal sectors we find generally lower segregation in the formal sector. Gender segregation is substantially more severe in the non-formal than in the formal sectors. The formal sector records 9.2 percent less gender segregation than in the labor market as a whole, while the informal sector has gender segregation which is 15.5 percent higher than the average value for the entire labor market. The pattern is different when examining racial segregation: during the 1990s racial segregation in the formal sector was higher than in the informal sector, but this trend was reversed by the beginning of the 2000s, with segregation somewhat higher in the non-formal sectors.

Perhaps more striking, we find that segregation has declined significantly faster in the formal sector, while remaining persistently high, and sometimes rising, in the non-formal sectors. Within the formal sector racial segregation has decreased slightly faster (8.3 percent) than gender segregation (7.7 percent), while in the informal sector gender segregation has been decreasing faster (5.6 percent) than racial segregation (3.1 percent). In both cases, the rate of decrease in the informal sector lags behind the formal sector. The most striking finding relates to racial segregation in the informal sector, which has increased sharply since the mid-1990s after experiencing a significant decline in the early years of the analysis. Between 1992 and 2006, gender segregation decreased by 10.4 percent in the informal sector, while racial segregation increased by 24.8 percent—a troubling trend from a social perspective, and one which is disguised when looking at patterns within the labor market as a whole.

Finally, it is also possible to disaggregate segregation trends based on demographic, education, sector, or spatial groupings. Among the most interesting findings that emerge is that gender segregation has declined much more rapidly among the relatively more educated. This, in turn, offers important insights into divergent trends between the formal and informal sectors, with gender segregation declining more rapidly in the formal sector in part owing to a higher share of more educated workers. Interestingly, the same relationship between education and segregation does not apply for non-white workers. These estimates are not included here to conserve space but are available upon request.

### 3.3. *Comparison to Previous Findings*

The only two studies to have examined levels of occupational segregation in Brazil are Oliveira (2001) and King (2009), though they cover a more restricted time period than that used in this study. Our estimates for the Duncan Index, during the corresponding years from 1987–99 and 1989–2001, respectively, lie roughly within the results reported by both these studies. This is the case both in terms of the magnitude of segregation, and in terms of the extent of decline over

time. What the current study adds is both an insight into more recent trends, and highlighting the important patterns that emerge when we disaggregate by formal and non-formal sectors.

It is equally important to compare Brazilian trends to those found elsewhere in Latin America. Isaza-Castro and Reilly (2009) have explored the evolution of gender segregation from 1986 to 2004 in Colombia and find an overall decrease in segregation of roughly 9.3 percent, with the Duncan Index moving from 0.55 to 0.49. This rate of decrease is somewhat faster than what we find for Brazil, where gender segregation declined by 6.4 percent over the same period. Deutsch *et al.* (2005) have explored the evolution of gender segregation in other Central and South American countries—Costa Rica, Ecuador, and Uruguay—over a slightly earlier period, from 1989 to 1997, and report significant declines in gender segregation across these three countries (respectively, 5.2, 6.9, and 1.8 percent). This presents a striking contrast to the findings for Brazil, where the Duncan Index declined by less than 1 percent during the same period, with a much more rapid decline in gender segregation only beginning at the end of the 1990s. It is thus unclear whether Brazil has simply experienced a smaller decline in gender segregation than many of its neighbors, or whether these changes simply began later, perhaps reflecting the speed of economic reform in the early 1990s.

King (2009) estimates racial segregation between 1989 and 2001 in Brazil and discovers diverging trends between female and male workers. Between 1989 and 2001 the author finds declining racial segregation among female workers (moving from 0.25 to 0.22), while the study also finds that segregation has been effectively unchanged among males (moving from 0.221 to 0.228). Our results over a broader time frame (1987 to 2006) report similar trends, with racial segregation having declined among women by 11 percent while remaining persistent for men. If we turn to the U.S. case using results reported by King (1992) and Hirsch and MacPherson (2004), we find that between 1988 and 1998 the U.S. labor market experienced a decrease in racial segregation of roughly 4.7 percent for male workers and 15.1 percent for female workers. Comparison with the more rapid decline of segregation in the U.S. thus further highlights the disconcerting persistence of such segregation in Brazil.

### 3.4. *Robustness Checks*

We perform several checks in order to ensure the robustness of our findings. First, we use alternative measures of segregation. The Duncan Index is the most intuitive measure to interpret and also the most commonly used in the literature, and facilitates comparison with earlier research in both Brazil and elsewhere. The alternative measures that we adopt are the Karmel and Maclachlan Index and the Gini Segregation Index. The mathematical expressions for these indices are presented in Appendix 3. We present the trend over time for these indices in Figure 2, while Tables A2 and A3 in Appendix 2 report values for five selected years and their bootstrapped confidence intervals across all sectors. The results using alternative measures all follow a broadly similar trend over time, increasing our confidence in the core results.

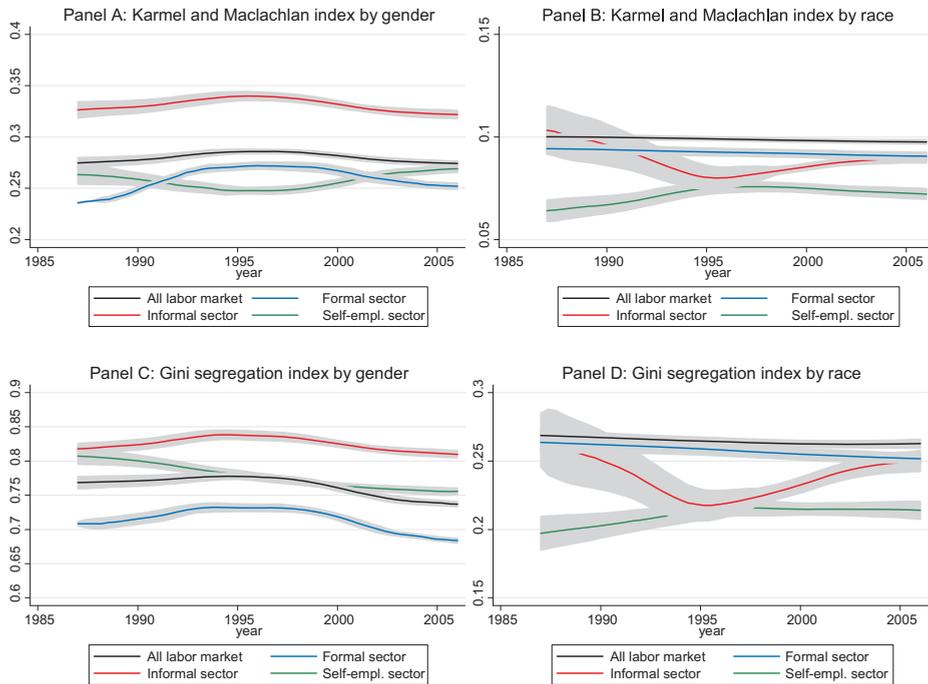


Figure 2. Robustness Check: Evolution of Occupational Segregation over Time using Alternative Measures

Source: Author’s computations using PNAD from 1987 to 2006. 1991, 1994, and 2001 are missing years. The projections are done using the local polynomial smooth plots with confidence intervals.

When using the Karmel and Maclachlan Index the trends over time are broadly consistent with the other indices. The Karmel and Maclachlan Index denotes the total labor force that would need to be relocated, with replacement, in order to reach zero segregation while retaining the initial occupational structure and overall female and male shares of the workforce (Karmel and Maclachlan, 1988). This is in contrast to the Duncan Index, which calculates the number of female workers that would need to be moved without replacement, and thus allows for changes in the occupational distribution (Watts, 1998). When the Duncan Index is decreasing, the Karmel and Maclachlan Index tends to remain constant and in some cases even increases slightly. This implies that although the female–male differential has narrowed, the increasing number of women entering the labor market means that the proportion of workers that would need to shift occupations in order to eliminate segregation has not changed, or has increased slightly (Karmel and Maclachlan, 1988).

Instead of looking at mean deviations, as is the case for Duncan-type indices, the Gini Segregation Index uses mean differences to measure the dispersion of the occupational distribution. Thus, segregation appears to be a more severe problem when focusing on compositional differences among all occupations together (which is the case when using the Gini Index) than when focusing on how gender

TABLE 1  
ROBUSTNESS CHECK: ACCOUNTING FOR “NO WAGE” OBSERVATIONS

	1987	1992	1997	2002	2006
<b>Panel A: Sample size including “no wage” obs.</b>					
Total					
# of obs.	98,982	102,346	114,815	135,902	152,343
Plus random missing wage obs. (1)					
# of obs.	703	2,466	2,023	2,206	2,358
%	0.67%	2.06%	1.55%	1.44%	1.38%
Plus “not remunerated” workers (2)					
# of obs.	5,801	14,694	14,070	14,602	15,655
%	5.50%	12.30%	10.75%	9.56%	9.19%
Total + (1) + (2) = sample size including “no wage” obs.					
# of obs.	105,486	119,506	130,908	152,710	170,356
<b>Panel B: Comparison of non-formal sectors including/excluding “no wage” obs.</b>					
Share of non-formal sectors (excluding “no wage” obs.)					
%	54.64%	53.36%	54.83%	55.69%	53.40%
Share of non-formal sectors (including “no wage” obs.)					
%	57.13%	59.10%	59.69%	59.93%	57.68%

*Note:* The “no wage” observations category is the total sum of the observations retained in our analysis (with no missing observation for wages or occupations) plus workers who are not remunerated and observations for which the wage variable is missing.

*Source:* Author’s computations using PNAD 1987–1992–1997–2002–2006.

and racial ratios differ from the overall composition of the workforce within each occupation individually (as in the Duncan Index case). The Gini Segregation Index is equal to the Gini Index of the female–male ratio where the weights are the shares of each occupation in the total male workforce (Silber, 1989a, 1989b). Overall, the trends over time are again similar to those obtained using the Duncan Index, thus reinforcing confidence in the results presented so far.

The second check that we perform is to test the robustness of our findings to our decision to exclude “no wage” observations during the core analysis. The “no wage” category includes workers that are not remunerated and respondents that randomly failed to report their wages (i.e., missing wages in the strict sense). The exclusion of these observations might thus underestimate the magnitude of the non-formal labor markets, thus altering reported estimates of occupational segregation. Those that failed to report their wages comprise, on average, only 1.4 percent of the entire sample (see panel A of Table 1), and we check whether missing wage observations are randomly distributed across occupations and across the formal, informal, and self-employed sectors. We confirm that the observed profile of those with missing wage observations is broadly similar across the entire sample, which, coupled with the limited number of such observations, suggests that there is little risk of any undue influence on the results exerted by this exclusion decision.

By contrast, not remunerated workers represent a considerable share of the sample, at 9.5 percent on average (shown in panel A of Table 1 and highlighted graphically in panel A of Figure 3). More importantly, “not remunerated” workers are non-random, and generally report employment in own-production, own-construction, or as a member of the household, primarily in the agricultural

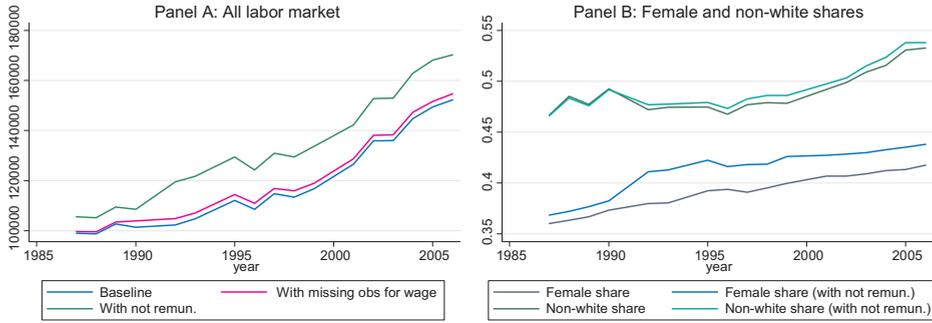


Figure 3. Robustness Check: Accounting for “No Wage” Observations

Source: Author’s computations using PNAD from 1987 to 2006. 1991, 1994, and 2001 are missing years.

sector. Furthermore, “not remunerated” workers are overwhelmingly women and primarily non-white, as evidenced by the increase in the female and non-white shares of the labor force if they are included in the sample (see panel B of Figure 3).

Consistent with a previous study by Ramos and Ferreira (2005), we find that adding “not remunerated” workers to the sample increase our estimate of the size of the informal sector from 54.4 to 57.8 percent of the labor market, while we no longer see a decline in informality over time. Turning to the impact of excluding “not remunerated” workers on our measures of segregation, we compute the Duncan Index using a sample that includes “not remunerated” workers. The inclusion of “not remunerated” workers in the analysis results in a decrease in our measures of segregation by both gender and race, though the overall trends remain largely unchanged. This is what we would expect given that the majority of “not remunerated” workers are actually female and non-white.<sup>8</sup>

#### 4. DECOMPOSING CHANGES IN SEGREGATION OVER TIME

In order to better understand the underlying forces driving changes in occupational segregation we adopt the decomposition method proposed by Deutsch *et al.* (2009), which combines the Karmel and Maclachlan (1988) decomposition and the concept of the Shapley value (Shorrocks, 1999; Sastre and Trannoy, 2002). This decomposition method permits the decomposition of changes in the segregation measures into three main components over time. First, segregation can change over time because of changes in the relative weights of different occupations. Second, segregation can change over time because of variation in the sub-population (gender or racial) composition of the total labor force. Third, segregation may change over time because of variation in the sub-population composition

<sup>8</sup>In 1987 gender segregation was computed to be 0.60 when excluding “not remunerated” workers and declined to 0.56 when these are included (a 7 percent decrease). In the same year, racial segregation was estimated to be 0.199 and decreased to 0.191 with the inclusion of “not remunerated” workers (a 4 percent decrease).

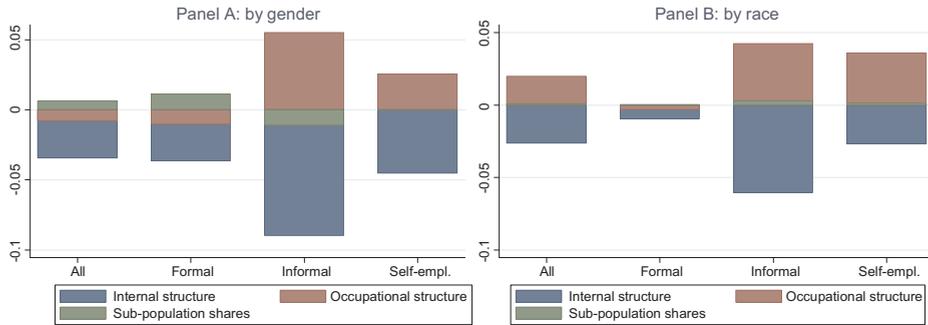


Figure 4. Contribution of Different Components to Declining Segregation

Source: Author’s computations using PNAD 1987,1988, 1989, 1990, 1992 and 2002, 2003, 2004, 2005, 2006.

within each occupation. This latter source of variation is also defined as “net segregation,” or variation in the “internal structure.” It is distinct from variation that can occur “in the margins,” which is given by changes in the relative weights of occupations and in the shares of sub-populations in the labor force. The sum of these three sources of variation (i.e., the internal structure and the two components of the margins) is defined as “gross variation.” In the following sub-sections, we present the core results and discuss key messages, while a detailed description of the decomposition method is presented in Appendix 4.

#### 4.1. Empirical Findings

We use the Duncan Index to decompose the changes in gender and racial segregation between two periods: the initial period, comprising the years 1987, 1988, 1989, 1990, and 1992; and the final period, comprising the years 2002 to 2006. We aggregate the first and last five years periods in order to ensure a sufficient number of observations to implement the decomposition separately across the formal, informal, and self-employed labor markets. This aggregation does not appear to be problematic, as changes in occupational distribution within the aggregated years are relatively modest. Finally, we also compute bootstrapped confidence intervals for the overall changes as well as for the components of these changes using draws from 500 random samples for inferential purposes. The findings from the decomposition of changes in the Duncan Index over time across the formal, informal, and self-employed labor markets are illustrated in Figure 4 and reported in Table A4 of Appendix 2. The decomposition results for the Karmel and Maclachlan Index and the Gini Segregation Index are reported in Tables A5 and A6 of Appendix 2. The overall pattern of results is consistent with the findings reported here.

In general, we observe that the decline in both gender and racial segregation, known as the “gross variation,” is driven overwhelmingly by “variations in the internal structure” of occupations, which is defined as “net variation” in segregation (i.e., by a declining concentration by gender and race within individual occupations). The contribution of the internal structure component is almost always statistically significant, and the magnitude is similar for both gender and racial

segregation. In contrast, we find that the impact of “variations in the margins”—that is, changes in occupational structure (i.e., the occupation weights) and in the share of different population sub-groups in the overall labor force is either negligible or increases in magnitude with higher levels of occupational segregation. The role of variations in the margins in increasing segregation is particularly pronounced in the case of racial segregation, which explains the smaller overall decline in racial segregation over time.

The disaggregation of the analysis across the formal, informal, and self-employed sectors again reveals important differences that are disguised by the aggregate analysis. We find that while the non-formal sectors are characterized by larger reductions in segregation driven by changes in internal structure, there are also large increases in segregation as a result of changes in the margins, driven particularly by changes in the overall occupation structure (occupation weights) between the formal and informal sectors. In the formal sector, changes in the occupation structure have contributed to declining segregation, although the effect is only statistically significant in the case of gender. On the other hand, in the non-formal sectors changes in the occupational weights are a major source of upward pressure on the levels of both racial and gender segregation.

#### 4.2. Discussion

Over the last two decades the Brazilian labor market has experienced major changes in its overall composition. It has witnessed a large increase in female participation, with the share of female workers in the workforce increasing from roughly 36 percent in 1987 to 43 percent by 2006 (Wajman and Rios Neto, 2000; Soares and Izaki, 2002; World Bank, 2002a, 2002b). Non-white workers have also secured an increasing share of the labor market, becoming the majority of the workforce since 2003. In comport with many countries in the region this has been accompanied by a rapid increase in the relative size of the services sector, from 51.6 percent of the labor force in 1987 to 60.7 percent in 2010 (World Bank, 2011).

Given the rapid insertion of female and non-white workers into the labor force, declining segregation may appear unsurprising, with Semyonov and Jones (1999), for example, arguing that increased female participation tends to result in declining segregation. However, the decomposition results suggest a very different story: the decline in both gender and racial segregation has been driven overwhelmingly by the increasingly equitable representation of female and non-white workers within individual occupations. In contrast, we find that, after accounting for the other trends discussed, the increasing share of women and non-whites in the labor force has actually contributed to increasing segregation, with new entrants into the labor force disproportionately entering services occupations (e.g., house-keeping) in which women and non-whites, respectively, were already dominant. Thus, the overall pattern is one in which the growth of relatively segregated occupations in the tertiary sector has contributed to increasing segregation, but this has been more than offset by greater equity in the internal composition of occupations over time. Tomaskovic-Devey *et al.* (2006) report a similar finding when investigating the role of the service economy in reducing gender segregation in the U.S. More broadly, the fact that changes in the internal structure of

occupations have been the primary driver of declining segregation, both by gender and by race, suggests the occurrence of profound changes in the extent of race or gender based barriers to entry into historically segregated occupations.

This pattern of more equitable representation within occupations is readily apparent in looking at more detailed trends in the composition of occupations that have historically been male or female dominated. Formerly female dominated occupations have seen important increases in the share of male workers, particularly in teaching and the clerical positions. For example, 93.4 percent of teaching associate professionals were women in 1987, while this share had fallen to 82.8 percent in 2006; customer services clerks moved from having a female share of 83.1 percent in 1987 to 75.2 percent in 2006. A more revealing finding relates to a subset of historically male dominated occupations in which women have played an increasingly important role, including physics and engineers (from 12.7 to 22 percent), life science and health professionals (from 45.9 to 65.1 percent), and business and legal professions (from 36.2 to 55.7 percent). The only major exception to a trend towards greater occupational integration lies in the relatively brawn-intensive occupations, which have remained heavily male dominated (e.g., drivers or extraction and building trades workers).

In terms of racial segregation, we see similar overall changes in internal structure, though the details are somewhat different owing to lower levels of initial segregation. Among occupations that have historically been heavily dominated by non-whites, the share of non-white laborers has frequently declined, with the non-white share of mining, construction, manufacturing, and transport falling rapidly from 80.36 percent in 1987 to only 59.93 percent in 2006. This appears to have been offset by more modest but relatively widespread increases in the representation of non-whites in the erstwhile white dominated occupations, for instance life science and health professionals (from 17.8 to 24.6 percent) and teachers (from 25.3 to 38 percent).

The second set of important findings from the decomposition analysis relates to major differences in overall trends between the formal and non-formal sectors, with these differences serving to explain the generally greater persistence of segregation in the non-formal sectors. The improvements in the internal structure of occupations have been relatively universal across the formal and non-formal sectors. However, changes in occupational structure have only had a small impact on trends within the formal sector, but have tended to contribute to substantially higher segregation in the informal sector. This reflects the increased relative size of more segregated occupations, and the fact that new female and non-white entrants to the labor force have largely entered historically female and non-white dominated informal occupations. This is particularly true in relation to racial segregation, and largely explains the slower aggregate decline of racial segregation over time.

This trend is confirmed by a more detailed look at developments within particular occupations. This is best illustrated by personal services occupations, which are dominated by women (69 percent in 1987 and 65 percent in 2006) and non-white individuals (55 percent in 1987 and 61 percent in 2006). These occupations have experienced a rapid increase in their relative size, with much of this growth concentrated in the informal sector, particularly in occupations related to housekeepers and personal and protective services. These patterns are replicated

elsewhere as well, with female and non-white dominated occupations expanding comparatively rapidly, and largely in the non-formal sectors, leading to an increase in aggregate occupational segregation. Taken together, this striking difference in outcomes between the formal and informal sectors has potentially important policy implications.

## 5. CONCLUSIONS

In this study we investigated the magnitude and evolution over time of gender and racial occupational segregation, while exploring the underlying drivers of these changes. Overall, gender segregation is significantly greater than racial segregation. More importantly, gender segregation has fallen more rapidly over the last two decades than racial segregation, which has been surprisingly persistent. These contrasting trends are most apparent during the second decade covered by this study, as the decline in gender segregation has accelerated while that for racial segregation has been very modest. Whereas most previous studies in Brazil and elsewhere have focused exclusively on gender segregation, these results point clearly to the importance of investigating a racial dimension as well. Although gender segregation is much larger in absolute terms, the rate of recent progress has been significant. It could be argued that differences in psychological attributes may offer a partial explanation for these higher levels of segregation. In contrast, racial segregation is lower in absolute terms, but has seen very little progress over time, and cannot be easily explained away by differences in preferences. This suggests that it is an issue that demands substantially greater attention than has historically been the case in Brazil.

The application of the Shapley decomposition proposed by Deutsch *et al.* (2009) sheds light on the forces driving changes in segregation over time. Our results reveal that the decline in both gender and race based segregation is primarily the result of the more homogenous representation of women and non-whites within individual occupations. This is an important finding as there is a temptation to attribute declining segregation largely to increased labor market participation by previously underrepresented groups. The results reported here indicate that changes in occupational structure have contributed to increasing segregation, with many new entrants to the labor force joining occupations that were traditionally more segregated. The fact that there have been substantial improvements in the composition of individual occupations explains the overall decline in segregation, and this appears to represent a more profound change in the structure of labor market opportunities.

An important further contribution of this research has been to move beyond a focus on the labor market as whole in order to explore differences between the formal and non-formal sectors. In practice, we find significantly different trends across sectors, with declines in segregation by both gender and race heavily concentrated in the formal sector. Racial segregation has experienced only a negligible decline in the formal sector, while segregation by gender has declined only fairly slowly in the informal sector, while remaining substantially higher than in the formal sector. We gain additional insight into this process from the Shapley decomposition. The negative impact of changes in occupational structure on levels

of segregation is concentrated in non-formal labor markets, indicating that highly segregated occupations have expanded primarily in the informal labor market, whereas such segregation has been more restricted in the formal sector.

This evidence of very different patterns between the formal and non-formal sectors points toward the value of further research aimed at understanding the determinants of occupational segregation in different sectors. In particular, research into the role and effectiveness of anti-discrimination legislation is required. A decline of occupational segregation in the formal sector over the past two decades would indeed be expected if ADL had been effective in curbing discrimination (Heckman and Payner, 1989; Neumark and Stock, 2006). At a more detailed level, the rapid expansion of highly segregated occupations within the informal sector, as revealed by the Shapley decomposition, is suggestive of the possible impact of ADL in limiting segregation within the formal sector—and of the possibility that ADL may lead some activities to be concentrated outside the reach of state regulation. This is most vividly apparent in the personal services sector, which has grown slowly in the formal sector but rapidly in the informal sector, while remaining highly segregated. However, while the findings across the formal and informal sectors are consistent with an impact of ADL on segregation, establishing clear causation is significantly more challenging. This remains an area for future research.

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## SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

**Appendix 1:** List of studies on gender and racial segregation

**Appendix 2:** Additional Tables

**Table A1:** Duncan index of segregation

**Table A2:** Karmel and Maclachlan index of segregation

**Table A3:** Gini index of segregation

**Table A4:** Shapley decomposition of changes in Duncan index over time

**Table A5:** Shapley decomposition of changes in Karmel and Maclachlan index over time

**Table A6:** Shapley decomposition of changes in Gini index over time

**Appendix 3:** Mathematical expressions for the Karmel and Maclachlan and Gini segregation indices

**Appendix 4:** The Decomposition Method