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 draft has been prepared for the IARIW-IBGE Special Conference on "Income, Wealth and Well-being in Latin America" to be held in Rio de Janeiro, Brazil, on September 11-14, 2013.

Abstract: This study provides a unique analysis of the evolution of gender and racial occupational segregation in Brazil from 1987-2006. Employing a newly harmonized occupational classification, it provides new insights in the nature and evolution of occupational segregation and on the forces driving these changes over this prolonged period of time. Three major findings emerge. First, gender segregation is always greater than racial segregation, but racial segregation 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 the internal gender and racial composition within occupations.

Keywords: Occupational Segregation, Informality, Gender, Race, Brazil.
JEL Classification: J15, J16, J71, O17, O54.

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1. INTRODUCTION

Occupational segregation represents one of the core themes in the labor economics literature and it has been the subject of many theoretical and empirical studies over several decades.[1] However, despite the centrality of occupational segregation to any understanding of labor market outcomes, studies of occupational segregation have been very rare for developing countries. One of the reasons for the absence of studies in such countries has been the absence of sufficiently detailed and reliable data over time. This study seeks to address this gap in the existing research with a focus on Brazil, and makes three main contributions. First, it assesses the magnitude of occupational segregation both by gender and by race, thus addressing an important oversight of existing research and highlighting divergent trends across population sub-groups.[2] Second, it disaggregates the analysis between the formal, informal and self-employed sectors, shedding light on important different across sectors. Finally, it explores the drivers of changes in occupational segregation over time by applying a decomposition technique developed by Deutsch, Flueckiger and Silber (2009).

Similar to most developing countries, the analysis of occupational segregation in Brazil has been constrained by data availability, as a revision to the classification of occupational codes used in the Brazilian household survey, the *Pesquisa Nacional por Amostra do Domicilios* (PNAD), after 2001 has prevented consistent comparison over time. This study overcomes this barrier by employing the newly harmonized re-classification of occupational codes provided by Salardi (2013), which cover 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 makes it possible to capture changes in occupational segregation during a period in which Brazilian labor markets have experienced several institutional and macroeconomic shocks. These include the establishment of a new Constitution in 1988, structural economic reforms beginning in the early 1990s and negative external shocks at the end of the 2000. It is equally a period during which the government has introduced a range of anti-discrimination legislation (ADL) aimed at reducing occupational discrimination and, by extension, segregation.

[1] See, for example, Anker (1997), Reardon and Firebaugh (2002), Fryer (2010) for theories of occupational segregation by both gender and ethnicity and King (1992), Charles and Grusky (1995) and Watts (1997), among others, for influential empirical studies of these questions.

[2] For 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.

The analysis reveals that while gender segregation is significantly greater than racial segregation, it has fallen more rapidly over the last two decades. The persistence of racial segregation, which cannot be easily explained by differences in preferences and tastes, is a potentially troubling trend that stands in contrast to progress in curbing gender based segregation. The implementation of the Shapley decomposition proposed by Deutsch, Flueckiger and Silber (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 is simply the result of increasing labor market participation by women and non-whites, and thus not reflective of broader changes in labor market outcomes. 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 composition within individual occupations, which represents a more 'real', and encouraging, change.

Disaggregating the analysis into the formal, informal and self-employed sectors yields additional insights, in part because it provides an entry point for exploring the potential importance of ADL in limiting segregation. The formal sector provides the framework for regulated labor markets to function, and it is in the formal sector that ADL is expected 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 likely to be concentrated in already segregated occupations. While it is important to stress that this study does not establish causal relationships between segregation institutional reforms, the analysis offers insight 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 to assess the extent of segregation and its trend over time. Given that segregation is a core theme within

labor economics, studies measuring the extent of occupational segregation in individual countries have been surprisingly uncommon, and focused primarily on gender rather than racial segregation. A careful review of the literature has uncovered 29 studies that focus exclusively on measuring country-specific occupational segregation, of which 23 focus on gender[3] and only six on racial segregation.[4] In addition to these individual country studies, a few adopt a cross-country perspective. Charles and Grusky (1995), Blackburn, Jarman and Siltanen (1993) 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 in developing countries, with the exception being Deutsch et al (2005), who explore gender segregation in Costa Rica, Ecuador and Uruguay, Isaza-Castro and Reilly (2011) who study gender segregation in Colombia, and Anker, Melkas and Korten (2003) who analyze cross-country variation in occupational segregation in a sample comprising both developed and developing countries.

Focusing on Brazil, theoretical and empirical research that examines wage discrimination is extensive, but work looking at occupational segregation has been limited. To the best of the author's knowledge, the only empirical study that measures gender based occupational segregation over a protracted period of time in Brazil is de Oliveira (2001). This study finds that gender based occupational segregation declined during the period 1987 through 1999, with a decrease in the Duncan index of three percentage points using a 3-digit occupational classification (moving from 63.29 to 60.06). De 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 (de Oliveira, 2001). Significantly less research has explored occupational equality along racial lines, with Telles (1994) the only researcher to have investigated occupational inequality by race in Brazil. However, the scope of the research is limited: His analysis is focused on exploring the impact of industrialization on racial inequality, but the analysis is based on only three occupational groups (Telles,

[3] For the U. S. see Albelda (1986), Blau and Hendricks (1979), Baunach (2002), Cotter, Hermsen, and Vanneman (2003), Hutchens (1991, 2004), King (1992) and Watts (1995); for United Kingdom see Hakim (1992, 1993) and Watts (1998); for Australia see Lewis (1982), Moir and Selby-Smith (1979) and Karmel and Maclachlan (1988); for Ireland see Reilly (1991); for Israel see Neuman (1994, 1998), for Switzerland see Deutsch, Flueckiger and Silber (1994) and Flueckiger and Silber (1999), for Brazil see de Oliveira (2001), for Spain see Mora & Ruiz-Castillo (2003), for Mexico see Calonico and Ñopo (2007), for Colombia see Isaza-Castro and Reilly (2011).

[4] Among previously cited works, Albelda (1986), King (1992) and Neuman (1994, 1998) also explore racial occupational segregation. In addition we find two studies focusing specifically on racial segregation in the US: Boisso et al (1994) and Maume (1999).

1994). The absence of such research on racial inequality is particularly striking given the existence of a long-standing sociological literature highlighting the often un-discussed importance of racial inequality in the country.

While has thus been surprisingly little previous research into patterns of occupational segregation, an equally important limitation is that none of these studies distinguish between the formal and non-formal sectors. This is a potentially important oversight. First, there are good reasons why patterns may differ across the formal and non-formal sectors: the informal sector may offer a more flexible alternative for economic activity and, as such, different trends between the formal and non-formal sectors may reveal something about the impact of labor market regulations in shaping patterns of segregation. Second, differences between the formal and informal sectors may have important welfare implications, as those in the informal sector frequently face greater risk exposure, as 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. Parts of this literature have 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,[5] unpaid family workers, and domestic service workers (see Jatoba, 1987; and Gatica, 1989 cited in Carneiro, 1997). Other studies have adopted a definition of informality based on the payment of social security contributions (see 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* (Carneiro, 1997; Soares, 2004; Ulyssea, 2005). However, this apparent working consensus may still disguise remain definitional difficulties. In a more recent paper, Henley, Arabheibani and Carneiro (2009) compare three different

[5] In Jatoba (1987) self-employed individuals earning up to two times the minimum wage and employers earning up to five times the minimum wage are considered informal workers.

definitions of informality centered on: i) contract status, based on the possession of a signed labor 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% 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% of workers possessed a *carteira de trabalho* in 1995. Soares (2004) claims that in 1999 only 14 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, Goni and Maloney (2007) estimate that the informal private sector in urban areas increased by 10 % 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.[6] The most notable exception is Telles (1992), who highlighted the tendency to ignore gender and racial issues in the literature on Brazilian informality, the latter reflecting an assumption that the hiring process is "color blind". He found that women's 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, he 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 similar over time.

Growing interest in the informal sector has included growing recognition that the formal and informal sectors are interconnected (Cacciamali 1982). Bosch, Goni and Maloney (2007) confirm the conclusions of a model developed by Fiess, Fugazza and Maloney (2008) that 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. They find that both formal and

[6] Empirically, Abramo (2004) reports that in 2001 71.2% of white women and 76.2% of non-white women 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.

informal labor markets are highly pro-cyclical and strictly interrelated: 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.[7] 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 this evidence suggests a more positive view of informal markets, which may contribute to minimizing social instability during economic hardship and may offer employment opportunities outside the influence of government regulation (Carneiro, 1997).[8]

Finally, underlying this 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. Early research by Paes de Barros and Corseuil (2001) correspondingly explored the impact of labor market regulations and found no evidence of any effect of the extent of informality, concluding that changes in labor market outcomes can be attributed primarily to the macroeconomic developments in the economy. By contrast, Bosch, Goni and Maloney (2007) have more recently explored several factors, including trade liberalization and rigidities arising from the Constitutional reforms,[9] 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.[10] There is thus at least some evidence that labor market regulations have shaped patterns of formality and informality in recent decades – thus suggesting the patterns of occupational segregation in these two sectors may similarly be shaped by such regulation.

[7] The limited role of structural changes in justifying the expansion of the informal sector is also acknowledged in Ramos and Ferreira (2005).

[8] In his study, Carneiro (1997) argues that the growth of the Brazilian informal sector may reflect excessive intervention by the government.

[9] The constitutional changes that affect the labour market analyzed by Bosch, Goni and Maloney (2007) are specifically union power, firing costs and overtime (the reduction of the legal limit of working hours per week).

[10] Consistent with this view, Goldberg and Pavcnik (2003) analyze the impact of trade liberalization, measured by trade exposure and tariff changes, and again find no evidence of any effects on the extent of informality. It is also important to bear in mind other factors that may affect the size and expansion of the informal sector, including reforms in the public health sector and the large-scale migration of workers from rural areas to urban/metropolitan areas, primarily in the South-East of Brazil.

3. MEASURING OCCUPATIONAL SEGREGATION OVER TIME

Against this background, 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 methodology and core results, comparison to previous results and a series of robustness checks.

(a) Data

The analysis is based on the commonly used Brazilian national household survey (*Pesquisa Nacional por Amostra do Domicilios*, PNAD) from 1987 to 2006, with the start date reflecting the year in which the PNAD dataset re-introduced questions about race. 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 of the evolution of occupational segregation in Brazil over a protracted period of time, while also capturing recent developments. In order to overcome this problem, we adopt the newly harmonized re-classification of the PNAD occupational codes proposed by Salardi (2013), which allows for the analysis of a consistent set of occupational codes over two decades.

With this data in hand, we then draw on the literature in categorizing worker across the formal and informal sectors. While some studies that focus only on private sector employees, we focus on the entire labor market in order to be as inclusive as possible of broad trends. Following most recent studies, our definition of the non-formal sector includes workers without a *carteira de trabalho,* the self-employed and workers in small firms, though we account for possible difference between these groups by distinguishing between informal sector workers and the self-employed throughout the analysis (Maloney, 2004, Fields, 1990, 2005 cited in Almeida and Carneiro, 1997). The treatment of employers poses particular challenges given the difficulty of establishing their formal status. While Bosch, Goni and Maloney (2007) adopt the ILO definition, which treats employers with less than five employees as being in the informal sector, this approach is problematic to implement in practice, and the analysis here correspondingly excludes employers.[11] 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.

[11] The difficulty of adopting the ILO definition includes the fact that the threshold varies from country to country (see the discussion in Bosch, Goni and Maloney, 2007), while 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.

(b) Methodology and core results

The analysis itself is undertaken here by using the popular 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:

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

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.[12] 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. Furthermore, this index assigns equal weights to each occupation independent of its relative size (i.e., its share in the total workforce). Watts (1998) claims that the Duncan index fails to show occupation invariance, but it is invariant to the gender composition of the labor force. There are a large number of studies that have applied the Duncan index in order to measure occupational segregation.[13] 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, alternative segregation measures are employed as robustness check in the following sub-section.

Figure 1 presents the evolution of gender and racial occupational segregation over time across formal, informal and self-employed sector measured by the Duncan dissimilarity index.[14] The values for only five years at regular intervals (namely 1987, 1992, 1997, 2002, and 2006) are selected and reported in Table 1.[15]

[Figure 1 about here]

[Table 1 about here]

[12] The formulas reported refer to gender segregation; for racial segregation F and F_i have to be re-defined for non-white workers and M and M_i for white ones.

[13] These include, among others, Butler (1987) and Hutchens (1991) and King (1992) for the U.S., Watts (1998) for the U.K., Reilly (1991) for Ireland, Deutsch, Flueckiger and Silber (1994) for Switzerland and Neuman (1998) for Israel. Similarly, cross-sectional analysis using the Duncan index has been carried out by Charles and Grusky (1995) and Deutsch et al (2005), among others.

[14] The standard errors are computed using the bootstrap method, which estimates the distribution of the segregation measure by re-sampling with replacement 500 times in order to create multiple estimates of the statistics (Efron and Tibshirani, 1991, 1993). These distributions are then used to construct confidence intervals around the original points and ultimately to establish standard errors (see also Boisso et al, 1994).

[15] The values for the Duncan index of segregation for all 20 years and the standard errors are available upon request.

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*).[16] All indices of segregation have been computed using the harmonized 3-digit occupational classification proposed by Salardi (2013).[17]

We find that gender segregation is always considerably greater that 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 6.5% 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 statistically significant. We subsequently see a relatively rapid, and statistically significant, decline in gender segregation from 1995 to 2006. By contrast, racial segregation declined by only 4.2% between 1987 and 2006, while these improvements have been relatively consistent over time. There is thus no evidence of the type of rapid recent gains that are apparent in looking at gender segregation.

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 sectors than in the formal sector. The formal sector records 9.2% less gender segregation than the labor market as a whole, while the informal sector has gender segregation 15.5% higher than the average value for the entire labor market.[18] The pattern is different when examining racial segregation, where there has been no consistent and statistically significant difference in racial segregation between the formal and informal sectors. During the 1990s racial segregation in the formal sector was higher

[16] Despite the seemingly clear categorizations, the actual existence of a 'color continuum' makes classifications ambiguous and subjective. For instance, there is evidence that the racial classifications adopted by Brazilian tend to be influences by their socio-economic conditions (Lovell and Wood 1998, Wood 1991, Telles and Lim 1998).

[17] Figures on occupational segregation using occupational codes at the 2-digit level are available upon request. The patterns are very similar, but the extent of segregation is, on average, smaller. The more detailed the occupational categorization the greater is the outcome from any measures of segregation.

[18] Differences in levels of segregation across sectors are generally statistically significant at the 5% level. T-test for the mean differences across sectors are available upon request.

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 stubbornly high, and sometimes rising, in the non-formal sectors. Within the formal sector racial segregation has decreased slightly faster (8.2%) than gender segregation (7.7%), while in the informal sector gender segregation has been decreasing faster (5.5%) than racial segregation (3.1%). 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 rapidly since the mid-1990s after experiencing a significant decline in the early years of our sample. Between 1992 and 2006 gender segregation decreased by 10.4% in the informal sector, while racial segregation increased by 24.8% - a troubling trend from a social perspective, and one which is disguised when looking at the labor market as a whole.

(c) Comparison to previous findings

The only study to have similarly examined levels of occupational segregation in Brazil is De Oliveira (2001), though it focuses only on gender segregation and covers a more limited period than that used in this study. Our estimates for the Duncan index, during the corresponding years from 1987-1999, lie within the results reported by de Oliveira (2001) using 3-digit and 2-digit level classifications respectively. This is true both in term of the magnitude of segregation, and in terms of the extent of decline over time. What we add is insight into more recent trends, and into the important patterns that emerge when we disaggregate the formal and non-formal sectors.

It is equally illuminating to compare Brazilian trends to those found elsewhere using similar occupational classifications. Isaza-Castro and Reilly (2011) have explored the evolution of gender segregation from 1986 to 2004 in Colombia and find an overall decrease in segregation of roughly 9.3%, 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% 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 1989-1997 and report significant declines in gender segregation across their sample of countries (respectively, 5.2%, 6.9% and 1.8%). This presents a striking contrast to Brazil, where the Duncan index declined by less than 1% 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.

Turning to racial segregation there are significantly fewer existing studies, and we thus focus on a comparison with the U.S. case using results reported by King (1992) and Hirsch and MacPherson (2003). The comparison highlights how considerably the U.S. gap has been diminishing over time and thus the disconcerting persistence of such segregation in Brazil. Between 1988 and 1998 the U.S. labor market experienced a decrease in racial segregation of roughly 4.7% for male workers and 15.1% for female workers. Over the same time span racial segregation in Brazil has been increasing by roughly 8.8% for male workers and decreasing by 6.6% for female workers.

(d) Robustness checks

We perform several checks in order to ensure the robustness of our findings. First, we apply alternative measures of segregation. The Duncan index is the most intuitive measure to interpret and also the most commonly used in the literature, which facilitates comparison with earlier research both in Brazil and elsewhere. The alternative measures that we adopt are the Karmel and Maclachlan index and the Gini segregation index. We present the trend over time for these indices in Figure 2, while tables A1 and A2 in the appendix report values for five selected years and their bootstrapped standard errors across all sectors. The results using alternative measures all follow a broadly similar trend over time, differing primarily in magnitude. This increases our confidence in the core results, as the differences in magnitude between the indices can be easily explained by differences in their construction.

[Figure 2 about here]

When using the Karmel and Maclachlan index the estimated level of segregation is lower in aggregate terms, though the patterns of change 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 has meant 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).

In the case of the Gini segregation index, we see that it generates the highest figures among all of the indices with values in 2006 of 0.735 and 0.262 for gender and race, respectively (see Table A2 in the appendix). Instead of looking at mean deviations, as is the case for Duncan-type indices, the Gini 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 using the Gini Index, than when focusing on how gender and racial ratios differ from the overall composition of the workforce within each occupation individually, as in the Duncan index case. The G-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, 1989). While the magnitude of segregation thus differs across segregation measures by construction, the trends over time are similar. As such, there does not appear to be any major risk in focusing on the Duncan Index.

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% of the entire sample (see panel A of table 2), 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 to 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.

By contrast, not remunerated workers represent a considerable share of the sample, at 9.5% on average (shown in panel A of table 2 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 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% of the labour 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 are largely unchanged. This is what we would expect given that the majority of 'not remunerated' workers are actually female and non-white.[19]

[Table 2 about here]

[Figure 3 about here]

4. DECOMPOSING CHANGES IN SEGREGATION OVER TIME

In order to better understand the underlying forces driving changes in occupational segregation we adopt the decomposition methodology proposed by Deutsch, Flueckiger and Silber (2009), which combines insights from the Karmel and MacLachlan (1988) decomposition and the concept of the Shapley value.[20] We begin by describing the decomposition methodology, after which we present the core results and discuss the key messages.

(a) The decomposition methodology

The decomposition methodology aims to decompose changes over time in segregation measures into three main components. 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 *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

[19] In 1987 gender segregation was equal to 0.60 when excluding 'not remunerated' workers and declines to 0.56 when they are included - a 7% decrease. In the same year racial segregation was equal to 0.199 and decreases to 0.191 with the inclusion of 'not remunerated' workers - a 4% decrease.

[20] See also Shorrocks (1999) and Sastre and Trannoy (2002).

variation (i.e., the internal structure and the two components of the margins) is defined as 'gross variation'.[21]

Following the Deutsch, Flueckiger and Silber (2009) derivation, it is possible to decompose the changes over time in the Duncan index of segregation as follows:

$$\Delta I_D = I_v - I_p \tag{2}$$

where I_v and I_p represent the indices for the final and initial periods of time respectively. By applying the concept of the Shapley decomposition, the total variation defined as 'gross variation' in segregation over time can be decomposed as follows:

$$\Delta I = f(\Delta m, \Delta is) = C_{\Delta m} + C_{\Delta is} \tag{3}$$

where $C_{\Delta m}$ and $C_{\Delta is}$ represent the two main components of the decomposition, the component of the change due to variation in the 'margins' and the component of the change due to variation in the 'internal structure' (or 'net segregation') and they are

$$C_{\Delta m} = \frac{1}{2} f(\Delta m) + \frac{1}{2}[f(\Delta m, \Delta is) - f(\Delta is)] \tag{4}$$

and

$$C_{\Delta is} = \frac{1}{2} f(\Delta is) + \frac{1}{2}[f(\Delta m, \Delta is) - f(\Delta m)] \tag{5}$$

The contribution of these components can be re-expressed also as follows:

$$C_{\Delta m} = \frac{1}{2}\{[I(s) - I(p)] + [I(v) - I(w)]\} \tag{6}$$

and

$$C_{\Delta is} = \frac{1}{2}\{[I(w) - I(p)] + [I(v) - I(s)]\} \tag{7}$$

where the set of matrices employed in the above equations are obtained by interacting both the margins and internal structure of the segregation matrices from which the two indices I_v and I_p can be drawn. The two initial matrices are P and V and we need to compare them to derive matrix S, which has the internal structure of P but the margins of V. In the same way, matrix W can be derived with the internal structure of matrix V and the margins of matrix P simply by inverting the process.

In order to explain the derivation, we first consider the matrix P. This matrix has the ratio T_{ij}/T in its internal structure where T_{ij} is the number of individuals in occupation *i* from the sub-population *j*

[21] The Shapley decomposition by Deutsch, Flueckiger and Silber (2009) is inspired by the decomposition technique proposed in Karmel and Maclachlan (1988). The important innovation in this new decomposition is the absence of an interaction term or residual from the decomposition.

and T is the total number of workers. The margins of matrix P are defined by $p_{i\cdot} = {}^{T_i}/_{T}$ and $p_{\cdot j} = {}^{T_j}/_{T}$ which are respectively the horizontal margins (occupational structure) and the vertical margins (shares of the sub-populations).

To derive the matrix S, we need to multiply all elements of P by the ratio ${}^{v_{i\cdot}}/_{p_{i\cdot}}$ and obtain an intermediate matrix X. Its elements need to be multiplied by the ratio ${}^{v_{\cdot j}}/_{x_{\cdot j}}$ to obtain a new matrix Y and so on. After several iterations, the matrix will converge to the matrix S with the internal structure of P and the margins of V (see Deming and Stephan, 1940). As already noted, we could also start with the matrix V and, by applying the same procedure, end up with the matrix W that has the internal structure of matrix V and the margins of matrix P.

Now, the proposed decomposition permits us to decompose the variation in the margins into components due to the variation in the occupational structure and the shares of the sub-populations. In other words, we have

$$C_{\Delta m} = C_{\Delta h} + C_{\Delta t} \tag{8}$$

where $C_{\Delta h}$ represents the contribution from changes in occupational structure and $C_{\Delta t}$ represents the contribution from changes in the shares of sub-populations in the total labor force. Using the same procedure as before we can express these two components as follows:

$$C_{\Delta h} = \tfrac{1}{2}\tfrac{1}{2}[\{[I(l) - I(p)] + (I(s) - I(k)]\} + \{[I(v) - I(c)] + (I(f) - I(w)]\}] \tag{9}$$

and

$$C_{\Delta t} = \tfrac{1}{2}\tfrac{1}{2}[\{[I(k) - I(p)] + (I(s) - I(l)]\} + \{[I(v) - I(f)] + (I(c) - I(w)]\}] \tag{10}$$

In order to derive these components we need to define additional matrices (see Deutsch, Flueckiger and Silber (2009) for the detailed construction of these matrices):

- matrix L with the internal structure of P, the horizontal margins of V and the vertical margins of P;
- matrix K with the internal structure of P, the horizontal margins of P and the vertical margins of V;
- matrix F with the internal structure of V, the horizontal margins of V and the vertical margins of P;

- matrix C with the internal structure of V, the horizontal margins of P and the vertical margins of V.

Through this decomposition, we are then able to decompose the change of the Duncan index of segregation between two periods into:

$$\Delta I_D = C_{\Delta is} + C_{\Delta h} + C_{\Delta t} \quad (11)$$

where $C_{\Delta is}$ represents the variation due to changes in the sub-population shares within occupations (the net segregation or changes in internal structure), $C_{\Delta h}$ represents the variation due to changes in the occupational structure of the labor markets (i.e., the weights of each occupation) and, finally, $C_{\Delta t}$ represents changes in the sub-population shares of the total labor force (i.e., gender or racial composition of the labor force).

(b) Empirical findings

We perform the decomposition of changes in gender and racial segregation using the Duncan index between two periods: the initial period, comprising the years 1987, 1988, 1989, 1990 and 1992[22], and the final period, comprising the years 2002 to 2006. We aggregate the first and last five years periods in order to have 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 conflated years are relatively modest. Finally, we also compute bootstrapped standard errors for the overall changes in occupational segregation, as well as for the components of these changes, using draws from 500 random samples in order to test the statistical significance of the point estimates for each component. The findings from the decomposition of changes in the Duncan index over time across the formal, informal and self-employed labor markets are reported in table 3 and depicted in figure 4.[23]

[Table 3 about here]

[Figure 4 about here]

In general, we observe that the decline in both gender and racial segregation, which is also called the 'gross variation', is driven overwhelmingly by 'variations in the internal structure', also called 'net variation' in segregation – that is, by declining concentration by gender and race within individual occupations. The contribution of the internal structure component is almost always statistically

[22] The PNAD survey was not carried out in 1991.

[23] For the Karmel and Maclachlan index and the Gini segregation index, the decomposition results are reported in the appendix in tables A3 and A4. The overall pattern of results is consistent with the findings reported here.

significant, and the magnitude is similar for both gender and racial segregation. By contrast, we find that the impact of 'variations in the margins' – that is, changes in occupational structure (occupation weights) and in the share of different population sub-groups in the overall labor force - is either negligible or increases 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.

When we disaggregate the analysis across the formal, informal and self-employed sectors it again reveals important differences that are disguised by the aggregate analysis. At a broad level, we find that while the non-formal sectors is characterized by larger reductions in segregation driven by changes in internal structure, but also by large increases in segregation as a result of changes in the margins. This overall pattern is driven particularly by differences in the impact of changes in occupational structure (occupation weights) between the formal and informal sectors. In the formal sector, changes in 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 occupation weights are a major source of upward pressure on levels of both racial and gender segregation, with a particularly dramatic effect in the case of racial segregation and in the self-employed sector.

(c) Discussion

The first major finding from the decomposition analysis is that 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. Earlier studies have suggested that declining gender segregation in Brazil, and elsewhere in the developing world, has been driven primarily by the increased entry of women into the labor market (de Oliveira 2001). These findings have suggested that while there has been progress in enabling women to join the labor market generally, patterns of discrimination within occupations have remainder relatively unchanged, with women continuing to face important barriers to entry into male dominated occupations. The implication has sometimes been that these reductions in discrimination are thus somewhat illusory and misleading. By contrast, the findings here make clear that this simple narrative is overly simplistic. After accounting for the other trends discussed so far, the increasing share of women and non-whites in the labor force has, in fact, contributed to *increasing* segregation, with new entrants to the labor force disproportionately entering occupations – like housekeeping – in which women and non-whites, respectively, were already

dominant. It is, instead, changes in the internal structure of occupations that have been the primary driver of declining segregation, both by gender and by race. The evidence here is thus suggestive of more profound changes in the labor market than has been suggested by earlier studies.

This pattern is readily apparent in looking at more detailed trends in the composition of occupations that have historically been extremely male or female dominated. Formerly female dominated occupations have seen important increases in the share of male workers, particularly in teaching and clerical positions. For example, 93.45% of teaching associate professionals were women in 1987, while this share had fallen to 82.8% in 2006; customer services clerks moved from having a female share of 83.13% in 1987 to 75.19% in 2006. More telling are a subset of historically male dominated occupations in which women have played an increasingly important role, including physics, engineers and sales positions. The only major exception to this trend towards greater occupational integration lies in relatively brawn-intensive occupations, which have remained heavily male dominated (e.g., drivers or extraction and building trades workers).

Turning to 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% in 1987, to only 59.93% in 2006. This appears to have been offset by more modest, but relatively widespread increases in the representation of non-whites in erstwhile white dominated occupations, such as life science and health professionals and teachers. Finally, and interestingly, there are a range of occupations in which non-whites have historically comprised about 60% of the total labor force and in which this share has remained relatively unchanged over time.

The second set of major findings from the decomposition analysis relate 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. Improvements in the internal structure of occupations have been relatively universal across the formal and non-formal sectors. By contrast, changes in occupational structure have had only 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 again borne out by a more detailed look at developments within particular occupations. This is most clearly illustrated by personal services occupations, which are dominated by women (69.03% in 1987 and to 65.1% in 2006) and non-white individuals dominated. These occupations have experienced a rapid increase in their relative size, with much of this growth concentrated in the informal sector, particularly for housekeepers and restaurant workers. A slightly different story emerges in the agricultural sector, which has had a high and increasing share of non-white workers and has seen the majority of its recent growth concentrated in the informal labor market. These patterns are repeated 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 implications, to which we return in the conclusions.

6. CONCLUSIONS

In this study we have 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. However, gender segregation has fallen more rapidly over the last two decades than racial segregation, which has been surprisingly stable. These contrasting trends are particularly apparent during the second decade covered by this study, as the decline in gender segregation has accelerated while the decline in racial segregation has been very modest. Whereas most previous studies in Brazil and elsewhere have focused exclusively on gender segregation, the very slow rate of progress in addressing racial segregation suggests that this is an issue that demands substantially greater attention.

The application of the Shapley decomposition proposed by Deutsch, Flueckiger and Silber (2009) sheds light on the forces driving changes in segregation over time. Our results suggest 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. Whereas previous research has attributed declining measures of occupational segregation to the rapid entry into the labor force of previously underrepresented groups, our results reveal that changes in occupational structure have, in

fact, contributed to increasing segregation, with many new entrants to the labor force joining traditionally more segregated occupations. It is, instead, substantial improvements in the composition of individual that explains the overall decline in segregation. This represents an arguably more meaningful source of declining segregation, and is thus an encouraging finding from a social perspective.

An important further contribution of the 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 this informal sector, while segregation by gender has declined slowly in the informal sector, while remaining substantially higher than in the formal sector. We gain additional insight into this process from the findings of 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 constrained in the formal sector.

This evidence of very different patterns between the formal and non-formal sectors points towards the importance of further research aimed at understanding the determinants of occupational segregation in different sectors. Of particular interest would be research into the role of anti-discrimination legislation, the more rapid decline of segregation in the formal sector over the past two decades is what we would expect if ADL is effective in curbing discrimination where those laws are enforced. At a more detailed level, the rapid expansion of highly segregated occupations within informal sector, 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 apparent in the personal services sector, which has grown slowly, and become less segregated, in the formal sector, while it has grown rapidly, and remained highly segregated, in the informal sector. 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. As such, this remains an area in which there are significant avenues for future research building on the suggestive results presented here.

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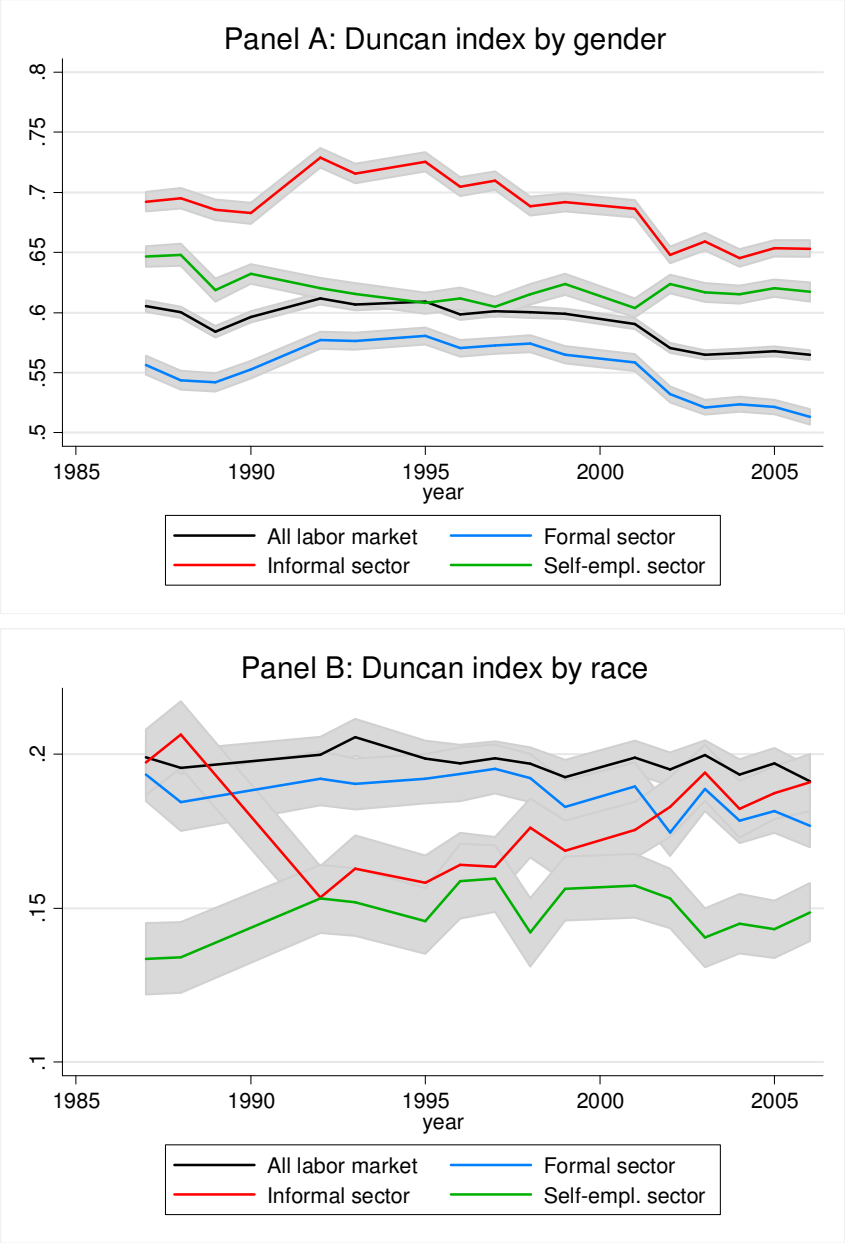
FIGURES AND TABLES TO BE INSERTED IN THE TEXT

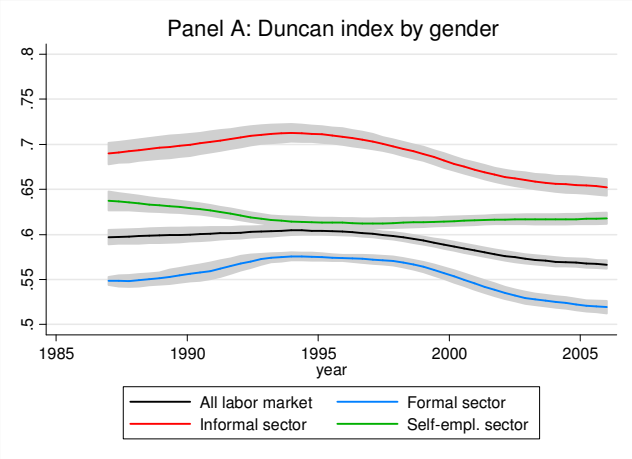
Figure 1 – Evolution of occupational segregation over time

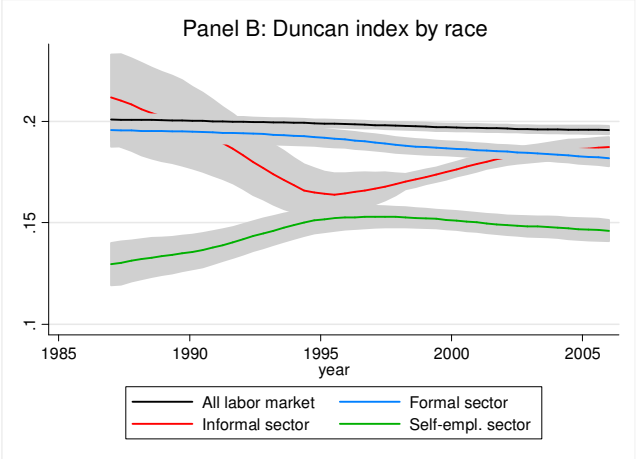


Source: Author's computations using PNAD from 1987 to 2006. 1991, 1994 and 2001 are missing years.

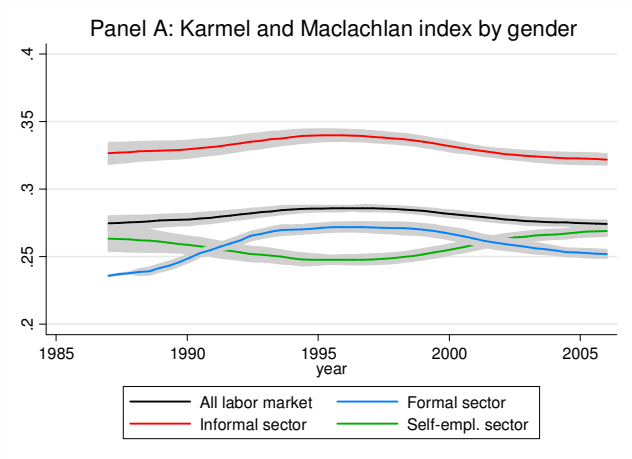
Figure 2 – Robustness checks: Evolution of occupational segregation over time using alternative measures

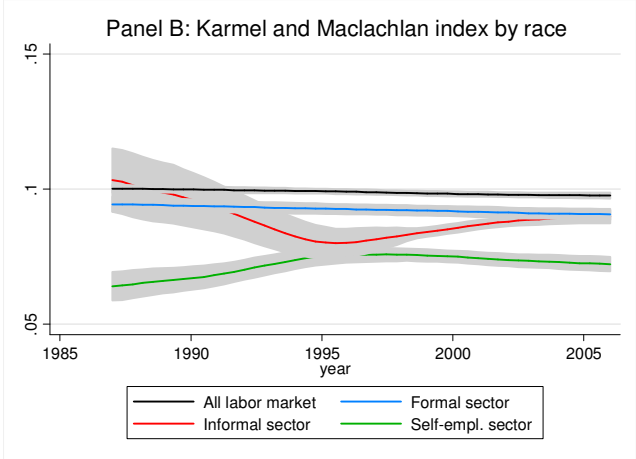
Panel A – Duncan index



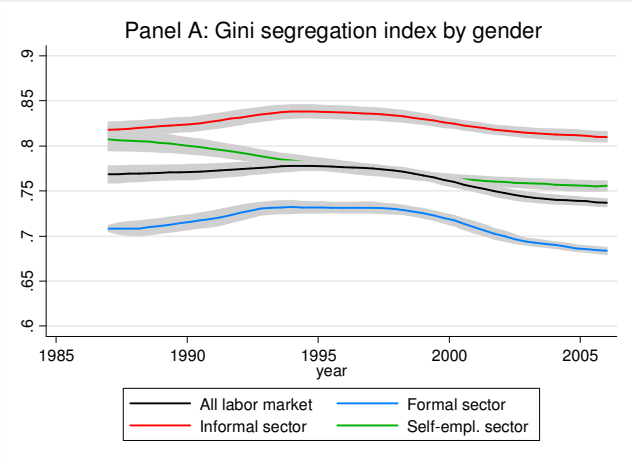


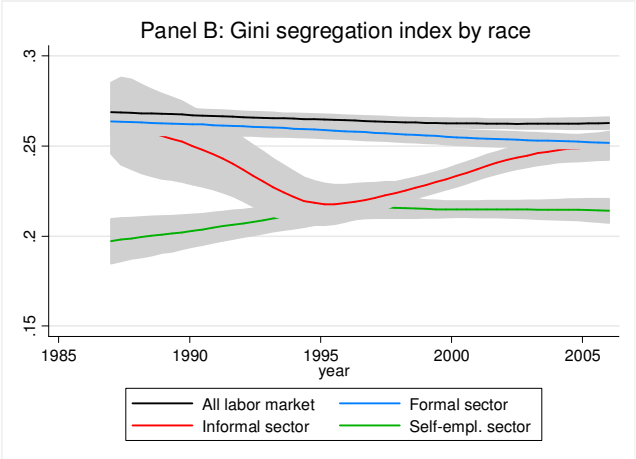
Panel B – Karmel and Maclachlan index





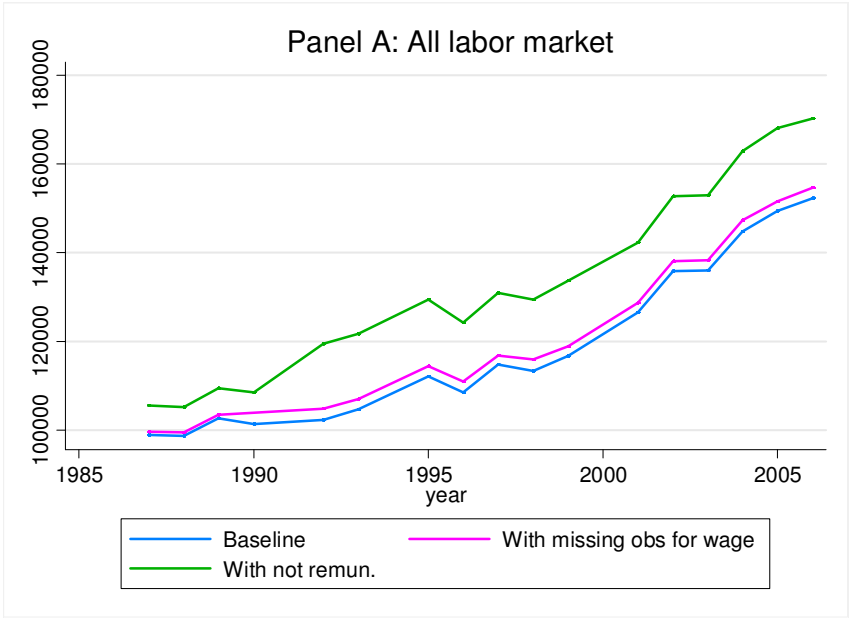
Panel C – Gini segregation index

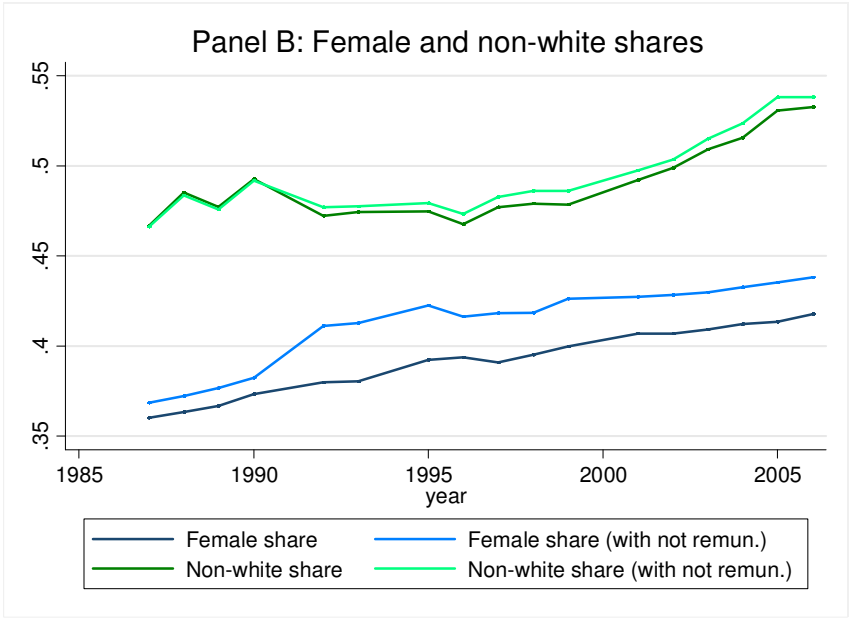




Source: Author's computations using PNAD from 1987 to 2006. 1991, 1994 and 2001 are missing years. The projections are done using the local polynomial smooth plots with confidence intervals.

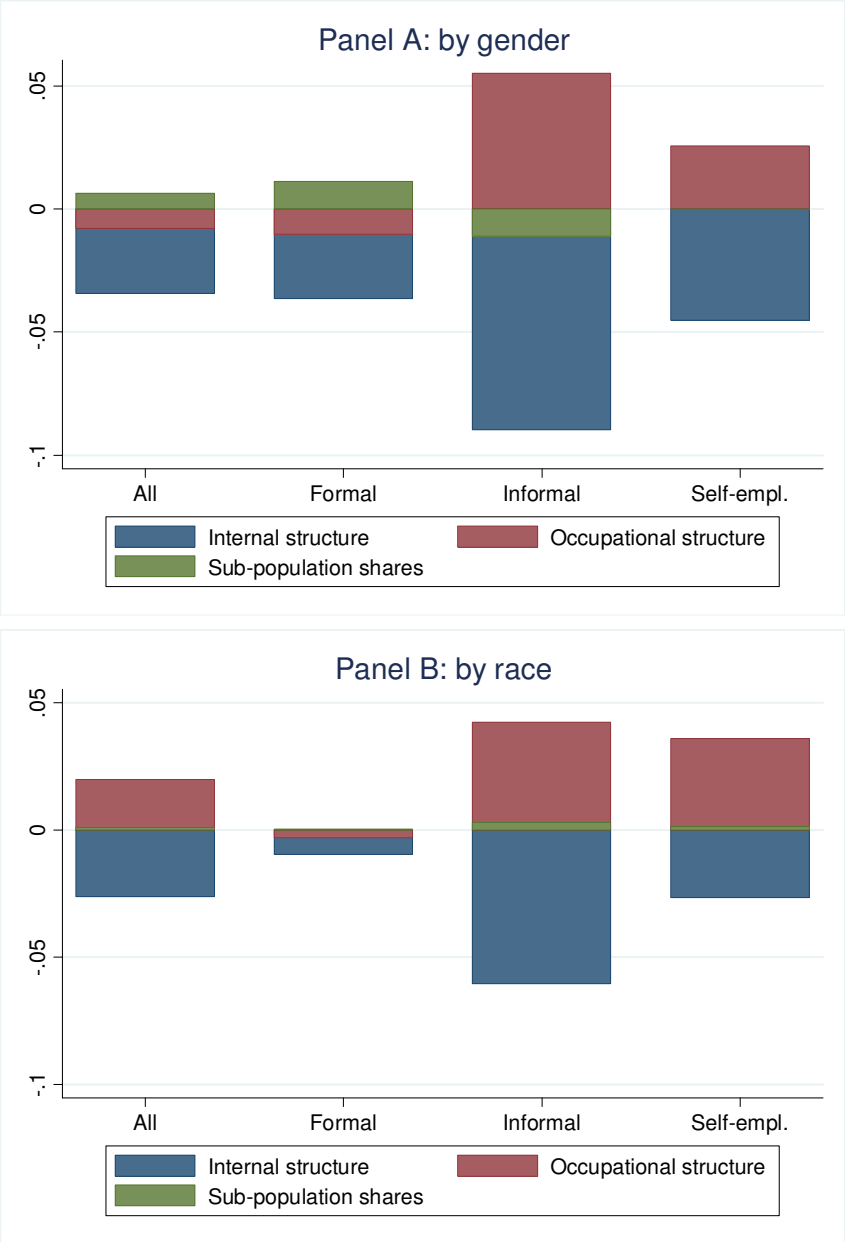
Figure 3 – Robustness check: Accounting for 'no wage' observations





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

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.

Table 1 – Duncan index of segregation

	1987	1992	1997	2002	2006	Diff 1987-2006	t-test
All labour market							
gender	0.605	0.612	0.601	0.571	0.565	-0.04	***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)		
race	0.199	0.200	0.199	0.195	0.191	-0.008	**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)		
Formal sector							
gender	0.556	0.577	0.572	0.532	0.513	-0.043	***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)		
race	0.193	0.192	0.195	0.175	0.177	-0.016	***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)		
Informal sector							
gender	0.692	0.729	0.710	0.648	0.653	-0.039	***
	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)		
race	0.197	0.153	0.163	0.183	0.191	-0.006	
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)		
Self-employed sector							
gender	0.647	0.620	0.605	0.624	0.617	-0.03	***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)		
race	0.134	0.153	0.160	0.153	0.149	0.015	*
	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)		

Source: Author's computations using PNAD 1987 – 1992 – 1997 – 2002 – 2006.
Note: Standard errors in parenthesis bootstrapped with 500 replications. All segregation indices are statistically significant at 1%. For the t-test of the difference over time between 1987 and 2006:* p<0.10, ** p<0.05, *** p<0.01.

Table 2 – Robustness check: Accounting for 'no wage' observations

	1987	1992	1997	2002	2006
Panel A – Sample size including 'no wage' obs.					
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
Panel B – Comparison of non-formal sectors including/excluding 'no wage' obs.					
Shares 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%

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

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.

Table 3 – Shapley decomposition of changes in Duncan index over time

	I_p	I_v	ΔI	$C_{\Delta is}$	$C_{\Delta m}$ (1) + (2)	$C_{\Delta h}$ (1)	$C_{\Delta t}$ (2)
All labor market							
gender	0.598***	0.562***	-0.036***	-0.034***	-0.002.	-0.008**	0.006***
	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)	(0.003)	(0.001)
race	0.198***	0.193***	-0.005***	-0.026***	0.021***	0.019***	0.001***
	(0.001)	(0.001)	(0.002)	(0.004)	(0.004)	(0.004)	(0.001)
Formal sector							
gender	0.553***	0.517***	-0.0359***	-0.036***	0.000	-0.011*	0.011***
	(0.002)	(0.001)	(0.002)	(0.005)	(0.005)	(0.005)	(0.001)
race	0.189***	0.177***	-0.012***	-0.009	-0.003	-0.003	0.001***
	(0.002)	(0.002)	(0.002)	(0.006)	(0.006)	(0.006)	(0.000)
Informal sector							
gender	0.695***	0.649***	-0.046***	-0.089***	0.044***	0.055***	-0.011***
	(0.002)	(0.002)	(0.002)	(0.010)	(0.010)	(0.011)	(0.002)
race	0.198***	0.183***	-0.015***	-0.060***	0.045***	0.042***	0.003***
	(0.002)	(0.002)	(0.003)	(0.008)	(0.008)	(0.008)	(0.000)
Self-employed sector							
gender	0.630***	0.609***	-0.020***	-0.045***	0.025*	0.025*	-0.001
	(0.002)	(0.002)	(0.003)	(0.014)	(0.014)	(0.014)	(0.000)
race	0.129***	0.140***	0.011***	-0.027***	0.037***	0.036***	0.001***
	(0.003)	(0.002)	(0.003)	(0.009)	(0.008)	(0.008)	(0.000)

Source: Author's computations using PNAD 1987,1988, 1989, 1990, 1992 and 2002, 2003, 2004, 2005, 2006.
Note: the initial period comprises 1987-1988-1989-1990-1992 and the final period comprises 2002-2003-2004-2005-2006. Standard errors in parenthesis bootstrapped with 500 replications; * p<0.10, ** p<0.05, *** p<0.01.

Appendix

Table A1 – Karmel and Maclachlan index of segregation

	1987	1992	1997	2002	2006	Diff 1987-2006	t-test
All labor market							
gender	0.277	0.286	0.285	0.275	0.275	-0.002	
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)		
race	0.099	0.099	0.099	0.098	0.095	-0.004	*
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)		
Formal sector							
gender	0.229	0.268	0.270	0.258	0.249	0.02	***
	(0.002)	(0.005)	(0.002)	(0.002)	(0.002)		
race	0.093	0.092	0.095	0.086	0.088	-0.005	*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)		
Informal sector							
gender	0.328	0.345	0.341	0.319	0.324	-0.004	
	(0.004)	(0.004)	(0.004)	(0.003)	(0.002)		
race	0.097	0.074	0.080	0.089	0.091	-0.006	*
	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)		
Self-employed sector							
gender	0.270	0.255	0.244	0.267	0.272	0.002	
	(0.005)	(0.007)	(0.004)	(0.003)	(0.003)		
race	0.066	0.076	0.079	0.076	0.073	0.007	*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)		

Source: Author's computations using PNAD 1987 – 1992 – 1997 – 2002 – 2006.
Note: Standard errors in parenthesis bootstrapped with 500 replications. All segregation indices are statistically significant at 1%. For the t-test of the difference over time between 1987 and 2006:* p<0.10, ** p<0.05, *** p<0.01.

Table A2 – Gini index of segregation

	1987	1992	1997	2002	2006	Diff 1987-2006	t-test
All labor market							
gender	0.776	0.785	0.775	0.743	0.735	-0.041	***
	(0.003)	(0.002)	(0.004)	(0.002)	(0.002)		
race	0.265	0.267	0.261	0.263	0.262	-0.003	
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)		
Formal sector							
gender	0.713	0.738	0.725	0.701	0.678	-0.035	***
	(0.005)	(0.004)	(0.003)	(0.003)	(0.003)		
race	0.259	0.262	0.259	0.247	0.244	-0.015	**
	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)		
Informal sector							
gender	0.819	0.845	0.838	0.810	0.810	-0.009	
	(0.006)	(0.005)	(0.005)	(0.003)	(0.003)		
race	0.249	0.203	0.215	0.239	0.256	0.007	
	(0.006)	(0.007)	(0.006)	(0.006)	(0.006)		
Self-employed sector							
gender	0.823	0.794	0.764	0.756	0.759	-0.064	***
	(0.004)	(0.007)	(0.004)	(0.004)	(0.003)		
race	0.196	0.224	0.218	0.221	0.218	0.022	**
	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)		

Source: Author's computations using PNAD 1987 – 1992 – 1997 – 2002 – 2006.
Note: Standard errors in parenthesis bootstrapped with 500 replications. All segregation indices are statistically significant at 1%. For the t-test of the difference over time between 1987 and 2006:* p<0.10, ** p<0.05, *** p<0.01.

Table A3 – Shapley decomposition of changes in Karmel and Maclachlan index over time

	I_p	I_v	ΔI	$C_{\Delta is}$	$C_{\Delta m}$ (1) + (2)	$C_{\Delta h}$ (1)	$C_{\Delta t}$ (2)
All labor market							
gender	0.279***	0.273***	-0.006***	-0.016***	0.010***	-0.004**	0.014***
	(0.001)	(0.000)	(0.001)	(0.002)	(0.002)	(0.002)	(0.000)
race	0.099***	0.096***	-0.003***	-0.013***	0.011***	0.010***	0.001***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.000)
Formal sector							
gender	0.254***	0.253***	-0.001	-0.017***	0.016***	-0.005*	0.021***
	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)	(0.003)	(0.001)
race	0.092***	0.088***	-0.004***	-0.005	(0.001	-0.002	0.002***
	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)	(0.003)	(0.000)
Informal sector							
gender	0.340***	0.323***	-0.017***	-0.044***	0.028***	0.027***	0.001
	(0.001)	(0.001)	(0.001)	(0.005)	(0.005)	(0.006)	(0.001)
race	0.098***	0.088***	-0.010***	-0.029***	0.020***	0.021***	-0.001***
	(0.001)	(0.001)	(0.001)	(0.004)	(0.004)	(0.004)	(0.000)
Self-employed sector							
gender	0.277***	0.267***	-0.009***	-0.020***	0.011*	0.011*	-0.001
	(0.001)	(0.001)	(0.001)	(0.006)	(0.006)	(0.006)	(0.001)
race	0.065***	0.070***	0.005**	-0.013***	0.018***	0.018***	0.000***
	(0.001)	(0.001)	(0.002)	(0.004)	(0.004)	(0.004)	(0.000)

Source: Author's computations using PNAD 1987,1988, 1989, 1990, 1992 and 2002, 2003, 2004, 2005, 2006.
Note: the initial period comprises 1987-1988-1989-1990-1992 and the final period comprises 2002-2003-2004-2005-2006. Standard errors in parenthesis bootstrapped with 500 replications; * p<0.10, ** p<0.05, *** p<0.01.

Table A4 – Shapley decomposition of changes in Gini index over time

	I_p	I_v	ΔI	$C_{\Delta is}$	$C_{\Delta m}$ (1) + (2)	$C_{\Delta h}$ (1)	$C_{\Delta t}$ (2)
All labor market							
gender	0.771***	0.736***	-0.036***	-0.043***	0.008***	0.005*	0.003***
	0.001	0.001	0.001	0.003	0.003	0.003	0.000
race	0.265***	0.261***	-0.004**	-0.036***	0.032***	0.030***	0.002***
	0.002	0.001	0.002	0.005	0.005	0.005	0.000
Formal sector							
gender	0.715***	0.683***	-0.032***	-0.054***	0.022***	0.013***	0.009***
	0.002	0.001	0.002	0.005	0.005	0.005	0.000
race	0.257***	0.245***	-0.013***	-0.016*	0.003	0.002	0.001***
	0.002	0.002	0.003	0.008	0.007	0.007	0.000
Informal sector							
gender	0.828***	0.808***	-0.019***	-0.084***	0.064***	0.066***	-0.001
	0.002	0.001	0.003	0.010	0.010	0.011	0.002
race	0.246***	0.243***	-0.003	-0.082***	0.079***	0.076***	0.003***
	0.003	0.002	0.004	0.009	0.009	0.009	0.000
Self-employed sector							
gender	0.807***	0.747***	-0.060***	-0.064***	0.004	0.004	0.000
	0.002	0.002	0.003	0.012	0.012	0.012	0.000
race	0.189***	0.204***	0.015***	-0.026**	0.041***	0.039***	0.002***
	0.003	0.003	0.004	0.010	0.010	0.010	0.000

Source: Author's computations using PNAD 1987,1988, 1989, 1990, 1992 and 2002, 2003, 2004, 2005, 2006.
Note: the initial period comprises 1987-1988-1989-1990-1992 and the final period comprises 2002-2003-2004-2005-2006. Standard errors in parenthesis bootstrapped with 500 replications; * p<0.10, ** p<0.05, *** p<0.01.