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Gender and Diversity Division

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Abstract*

We investigate differences in earnings penalties associated with working from home (WFH) between groups of gender and race before and during the COVID-19 pandemic in Brazil. Using a large and nationally representative longitudinal dataset, we show that the earnings penalty associated with WFH diminished for White and Black men during the pandemic while remaining high for White and Black women. We further examine three mechanisms explaining these changes: i) the equilibrium between supply and demand, as more women than men transitioned to WFH during the pandemic; ii) labor productivity, as the effective working hours of Black women were more affected by WFH; and iii) visibility and promotion, as White women became less likely than White men to be promoted when WFH during the pandemic.

JEL classifications: J16, J21, J31

Keywords: Gender and race disparities, Telework, Remote work, Labor market inequalities, Wage penalty

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1. Introduction

Traditionally, working from home (WFH) has been thought to reinforce pre-existing labor market inequalities (Golden et al., 2020; Goldin et al., 2011). This is because the prevalence and wage returns of WFH varies across social groups, usually in ways that disadvantage underprivileged social groups (Dingel et al., 2020; Bonacini et al., 2021). For example, women make up the majority of home-based workers (ILO, 2021) but are more likely to suffer from a wage penalty associated with WFH than men (Oettinger, 2011). With respect to race, Black workers are less likely to access WFH but usually face a greater wage penalty associated with WFH (Edwards et al., 2002; Amairisa et al., 2020).

The growing prevalence of WFH during the pandemic raises two important questions. First, how did the wage penalty associated with WFH change during the pandemic? Second, how did differences in wage penalties of WFH for workers of different genders and races change during the pandemic? While a growing literature explores the general impact of WFH on productivity (Emanuel et al., 2023; Atkin et al., 2023; Bloom et al., 2015), there is limited knowledge regarding how the wage penalty of WFH may have changed or persisted during the pandemic and how this evolution differed by social group. Also, research on topics related to WFH is generally scarce in developing countries. The study also has implications for public policy, such as furthering understanding of whether changes introduced during COVID-19 alleviated the earnings penalty of working mothers seeking jobs with more flexibility (Goldin et al., 2011), especially those from the most vulnerable social groups.

We analyzed these questions in Brazil, a society marked by a high level of gender and racial inequality and a dramatic increase in WFH during the pandemic. A survey of private companies in Brazil indicates that 86 percent practiced remote work in 2022, compared to 36 percent in 2014 (SAP Consultoria em RH, 2022). In general, nearly one-fifth of occupations in Brazil can be performed remotely (Barbosa Filho et al., 2022; Geraldo Sandovaldo Goes et al., 2022b). Nevertheless, the extent to which WFH reproduces gender and racial inequalities in Brazil remains unclear. While women make up the majority of workers in jobs that can be done from home, their earnings are significantly lower than those of their male counterparts. Additionally, Black workers are underrepresented in these positions and also earn less than White workers (Geraldo Sandovaldo Goes et al., 2022a).

To address the questions identified above, we used a unique longitudinal dataset that is representative of the Brazilian population to estimate the changes in earnings of those who shifted from WFO (working from the office) to WFH and vice-versa before and during the pandemic. Our fixed-effect estimators removed the potential selection biases from time-invariant characteristics, such as less productive workers being more likely to WFH. We also conducted additional tests to assess the robustness of the estimates against time-variant omitted variables (e.g., poor performance in the office) and attrition (e.g., individuals WFH less likely to experience job loss). Our results highlight how, during the pandemic, the earnings penalty associated with WFH diminished for White and Black men while remaining high for White and Black women. We further investigated three mechanisms that may explain these changes in the earnings penalty associated with WFH: the equilibrium between supply and demand for WFH, the impacts of WFH on labor productivity, and the decline in visibility and promotion in the office.

2. Literature Review

2.1. The Setting

Brazilian labor law formalized WFH (or teleworking) in 2011 (Presidência da República, 2011), equalizing labor rights between those who work from home and those who work from the office. In 2017, a new labor reform introduced guidelines for implementing and monitoring WFH in labor contracts (Presidência da República, 2017), making it easier for employers to hire people WFH and convert WFH workers to WFO workers. In 2018, Brazil had 3.8 million people WFH, which accounted for 4 percent of the workforce (Oliveira, 2020). This share was lower than most other Latin American countries, including Argentina, Chile, and Mexico, where between 5 percent and 15 percent of workers were WFH before the pandemic (ILO, 2021).

The COVID-19 pandemic forced employers to quickly transition to remote work to comply with social distancing measures. During the pandemic, remote work was recommended and encouraged for public sector employees, especially for their non-essential activities. In July 2020, 95 percent of education sector public servants and 49 percent of other civil servants were working remotely (Governo Federal, 2020). Meanwhile, the Brazilian government enacted legislation allowing private employers to temporarily change their employment regimes from the office to the home, and vice-versa, without requiring changes in labor contracts (Presidência da República, 2020a).

The number of those who worked remotely (including public and private workers) reached 8.6 million in June 2020, making up 12 percent of the total employed population (Oliveira, 2020). The law was in effect until December 2020. Now, in Brazil, there remains a relevant mismatch between employees willing to work remotely and employers willing to offer remote work. A survey across 27 countries in 2021 showed that Brazilian workers reported one of the greatest desires to work from home, 2.3 days/week, while Brazilian employers reported planning to offer only 0.7 days/week of remote work (Aksoy et al., 2022). The average of full days worked from home was 1.7 days/week.

It is important to note that nearly half of Brazil's labor force is self-employed or is in the informal sector, which often lacks written contracts and formal agreements (Banco Central do Brasil, 2019). Informal workers were the hardest hit by the pandemic, with less than half keeping their jobs and only 5 percent able to work from home in July 2020 (Carvalho et al., 2022; Geraldo Sandoval Goes et al., 2020). Informal workers may have also had to switch between WFO to WFH and have their wages reduced in the absence of any formal restrictions on such a practice. Labor contracts are supposed to safeguard formal workers against wage reductions when they shift from WFO to WFH. However, between 2020 and 2021, acts of legislation allowed employers to temporarily reduce their employees' working hours and wages or suspend their labor contracts altogether (Presidência da República, 2021; Presidência da República, 2020b). In July 2020, nearly one-third of formal employees were affected by these laws (Cavallini, 2020).

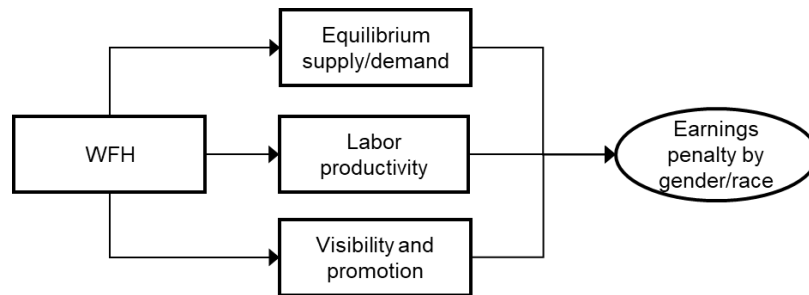
When evaluating the earnings penalty of WFH, we must consider differences between the formal and informal sectors as the transition between formal and informal employment. While the informal sector in Brazil is associated with higher earnings penalties and earnings volatility than in the formal sector (Engbom et al., 2022), people may frequently transition between formal and informal jobs. The rotation of the labor force in Brazil is high compared to developed countries, with nearly one-quarter of the employed population in one year transitioning to unemployment, inactivity, or to another job in the next year (Beccaria et al., 2020). The transition from the informal to the formal market is also high, ranging in metropolitan regions from nearly 20 percent for women to 30 percent for men (Maciel et al., 2018).

2.2.Mechanisms Linking WFH to Wage Inequality throughout the Pandemic

We focus on three mechanisms leading to changes in the earnings penalty of WFH and in the differential effects of WFH by gender and race during the COVID-19 pandemic (Figure 1). The

existing literature on these mechanisms primarily focuses on developed countries with limited consideration of comprehensive gender and racial differences and the role of intersectionality, e.g., differences between White men and Black women.

Figure 1. Mechanisms Linking WFH to Earnings Penalty



Source: Authors' formulation.

The first channel involves the equilibrium between the supply and demand for WFH (Oettinger, 2011). Before the pandemic, high wage penalties were expected for people WFH because the supply of such workers surpassed their demand, and therefore WFH was considered largely a job benefit for the flexibility and reduced commuting costs it offered (Amairisa et al., 2020). Employees thus accepted lower wages than their peers in similar occupations in exchange for better job amenities such as flexibility (Kouki, 2023). During the pandemic, disease mitigation measures shifted the equilibrium, with many more employers taking up remote work. With the expansion of remote work opportunities, employers competed on a broader scale to attract and retain skilled professionals, and therefore needed to offer competitive compensations, including higher wages. The sudden increase in demand for remote work also entailed increased investments in technology and infrastructure, such as high-speed internet at home, tools for collaboration, and video conferencing platforms. These fixed costs were offset by the long-term savings from reduced expenses related to office space (Mueller-Langer et al., 2022; Howe et al., 2021), which allowed for part of the savings to be allocated towards higher wages for remote workers. In this context, WFH was no longer simply a job benefit but often a necessity for work. It had become increasingly normalized as part of the job package. As a result, one would expect the earnings penalty of WFH to have decreased during the pandemic.

The supply and therefore the wage effects of WFH have not been evenly distributed across social groups. Given the traditional division of domestic labor within the family, women (especially

those with children) are generally more likely to supply WFH, which potentially leads to a greater wage penalty of WFH for women than for men (Oettinger, 2011; Kouki, 2023). This gendered pattern would be expected to continue, if not widen, during the pandemic, considering the increased caregiving activities taken up by women (Giurge et al., 2021). The relatively larger supply of WFH for women suggests they have faced a steeper wage penalty of WFH than for men, especially during the pandemic.

With respect to race, the pattern is different. Before the pandemic, Black workers (particularly Black women) tended to be more likely to supply WFH than Whites (Figure 2), suggesting a potential higher wage penalty for Black workers than their White counterparts before the pandemic. A possible explanation for this is that Black workers are overrepresented in informal employment in Brazil (Tatiana Dias Silva et al., 2021), where there is also a high prevalence of WFH. In low- and middle-income countries, nearly 90 percent of home-based workers worked informally before the pandemic (ILO, 2021). This gap tended to reverse during the pandemic, both because of the nature of their work (service, frontline workers) and their home environment. A disproportionate share of Black workers in the informal sector, many of them WFH, became unemployed or inactive during the pandemic (Tatiana Dias Silva et al., 2021). Simultaneously, WFH increased more dramatically for White workers than Black workers during COVID-19 (Figure 2). On the demand side, the proportion of occupations typically performed by Black workers with options for remote employment in Brazil is considerably lower than that of White workers (Barbosa Filho et al., 2022). As a result, we would expect a lower wage penalty of WFH for Black workers during the pandemic due to a lower increase of their supply.

The second mechanism is related to labor productivity. Despite a growing debate around whether WFH has a positive (Bloom et al., 2015) or negative effect on job performance (Emanuel et al., 2023), there is a longstanding and widespread perception among employers that remote work reduces productivity due to the lack of organizational commitment and distractions at home (Leslie et al., 2012), and that those who work from home are negatively selected (Atkin et al., 2023). Furthermore, there is a phenomenon known as “flexibility stigma” (Rao, 2020; Coltrane et al., 2013), i.e., negative attitudes towards workers who work flexibly for family purposes. Such perceptions, however, were bound to change during the pandemic. As WFH became a necessity across many workplaces and professions, this form of working arrangement became more widespread and thus less selective and increasingly disassociated from housework (Kong et al., 2022), which may have

weakened the connection between WFH and low productivity. Furthermore, employers' and workers' investments in technologies and training to support WFH enhanced its perceived and real productivity (Barrero et al., 2021). As a result, we would expect a reduction of the wage penalty of WFH linked to productivity during the pandemic.

The WFH-productivity relationship varies by gender and race. Previous research suggests that the perceived or real productivity-reducing effect of WFH is larger for women than men due to greater family responsibilities such as childcare and household chores, especially during the pandemic (Giurge et al., 2021). Whereas men tend to use flexible working time for performance-enhancement purposes (Lott et al., 2016), women often juggle between remote work and their family responsibilities, resulting in less uninterrupted work time for WFH (Chung et al., 2020). Families' caregiving responsibilities increased tremendously during the pandemic because of social distancing and school closures. These responsibilities were disproportionately carried by women (Möhring et al., 2021), leading to a decrease of their real or perceived productivity. Hence, women WFH, especially those with children, tended to be more stigmatized than their male counterparts (Chung, 2020). As a result, women may not have benefited from the overall reduction of wage penalties from WFH; instead, they may have experienced an even larger wage penalty from WFH than men during the pandemic.

With respect to race, the situation was very much the reverse. Before the pandemic, Black workers were more adversely affected by WFH, given the negative perceptions associated with WFH and selection into WFH (Bachrach et al., 2023). This tendency was exacerbated by the comparatively less advanced telecommunication technologies in Black households, which impeded their human capital and productivity (Nishijima et al., 2017; Ramos et al., 2020). However, with respect to technology, the circumstances improved across the board during the pandemic. Employers' growing investment in WFH enabled even previously disadvantaged social groups (e.g., Black workers) to keep their jobs and increase their productivity and performance while WFH (Bosua et al., 2017). This may have resulted in a lower wage gap for WFH between Black workers and White workers during the pandemic.

The third mechanism stems from visibility in the office and promotion. Social interaction and visibility in the office are critical components of developing strong work relationships and achieving career advancement such as promotion (Paula McDonald et al., 2008). One would expect remote work to decrease the potential for positive social interactions (e.g., reduce the frequency of one-on-

one meetings) and relationships, which would have negative consequences on earnings (Richardson et al., 2015). As a result, remote workers have traditionally been promoted at lower rates than their onsite peers (Emanuel et al., 2023; Chen, 2024). This situation, however, changed during the pandemic when many people were compelled to work from home. Under such a circumstance, the importance of social interaction and visibility for career advancement may have been reduced, perhaps even closing the gap in promotion rates (Emanuel et al., 2023). This could have resulted in a lower earnings penalty of WFH during the pandemic.

The aforementioned process may have had a disproportionate impact on disadvantaged social groups. Because of network segregation in the workplace, network processes have long been shown to reinforce and reproduce gender and racial inequalities (Steve McDonald, 2011; Combs, 2003). For example, White men tend to have more face-to-face interactions with managers, which accounts for their higher promotion rates than their women and Black counterparts (Cullen and Perez-Truglia, 2019). However, during the pandemic, the generally declining importance of visibility for career advancement may have reduced the gender and racial gap. Additionally, new virtual interactions replaced in-person forms of interaction, thus leading to more equitable social interactions and a reduction of the previous barriers that prevented underprivileged workers from accessing high-status networks (Cullen et al., 2019). As opportunities for workplace interactions became more equitable, Black workers and, to a lesser extent, women, may have suffered a lesser wage penalty of WFH. Women may have been less likely to benefit from this change because of their additional duties at home that could have limited their ability to maintain and grow their workplace social ties.

3. Data and Methods

3.1. Sample

We used longitudinal data from the quarterly PNADC (Continuous National Household Sample Survey), which can be accessed through the Brazilian Institute of Geography and Statistics (IBGE), to track a rotating panel of prime-aged (25-54 years old) workers between the 1st quarter of 2018 and the 4th quarter of 2022. Our analyses are split into two periods: before (1st quarter of 2018 and 1st quarter of 2020) and during COVID-19 (2nd quarter of 2020 and 4th quarter of 2022). PNADC is representative of the entire Brazilian workforce and is the most comprehensive source of labor market data in the country (IBGE, 2021b). Each household remains in the PNADC dataset for up to five

consecutive quarters. Because the PNADC dataset does not provide personal identification information, we matched individuals from the same household in different quarterly waves using sex and complete birthdate. We dropped 9.2 percent of observations with missing birth dates or repeated birth dates and sex in the same household (e.g., twins). We also dropped 0.2 percent of live-in domestic workers and individuals living in collective households because they are less likely to remain in the same household across waves.

Between March 2020 and July 2021, IBGE switched the in-person PNADC data collection to telephone-based interviews (IBGE, 2021c). This sudden change increased the non-response rate, which shifted from 12 percent in February 2020 to 40 percent in April 2020 (IBGE, 2020). In November 2021, IBGE adopted a new methodology to adjust the sampling weights to guarantee the quality and reliability of the data collected during the pandemic (Corseuil et al., 2022; IBGE, 2021c). We adopted the sampling weights in all of our estimates.

We separated out four gender and racial groups (White men, White women, Black men, and Black women). We also conducted separate analyses to evaluate the differences in gender (men and women) and race (White and Black). In the PNADC dataset, individuals report one of five categories of race/color: White, Black, Brown (*pardo*), Yellow (Asian), and Indigenous. We excluded Indigenous people, who represented 0.5 percent of the sample. We aggregated White (38.5 percent of the sample) and Asian (0.5 percent of the sample) into one single category (White, representing 39 percent of the sample). We grouped Black (9.5 percent of the sample) and Brown (51 percent of the sample) into another category (Black, 60 percent of the sample). These racial aggregations are commonly used in the literature on racial inequalities in Brazil (Telles, 2004; IBGE, 2019) because Whites and Asians have similar earnings after controlling for socioeconomic characteristics (Maia et al., 2015), and so do Black and Brown people (Gonçalves de Jesus et al., 2020).

Whether an individual worked from home is only reported by private-sector employees (nearly 48 percent of the labor force), self-employed workers (25 percent), and employers (5 percent). We excluded public-sector and unpaid workers because of a lack of information on their WFH figures. We also excluded employers because the mechanisms driving gender and racial inequalities for them differ from those of employees and self-employed workers. To expand the scope of our research on public policies in Brazil, we combined the sample of self-employed and private employees. This approach is similar to those used in other Latin American countries, such as Argentina and Mexico (ILO, 2021). Self-employed workers represent an overwhelming share of the informal sector in Brazil

(Ulyssea, 2006), and nearly 40 percent of workers in Brazil were in the informal sector in 2020 (IBGE, 2021d). Brazil's labor market reform in 2017 (Presidência da República, 2017) made self-employment contracts more formal and flexible, allowing self-employed individuals to perform tasks similar to private-sector employees within the same firm. The vast majority of home-based workers in our sample (85 percent) were self-employed. Analyzing private and self-employed workers separately may lead to attrition because a shift from WFO to WFH may correspond with a move from the private sector to self-employment. We also excluded three categories of workers to reduce the selection of people WFO and WFH: i) people working in vehicles (e.g., truck drivers and taxi drivers); ii) people working in public areas (e.g., street vendors); and iii) people working in unknown places.

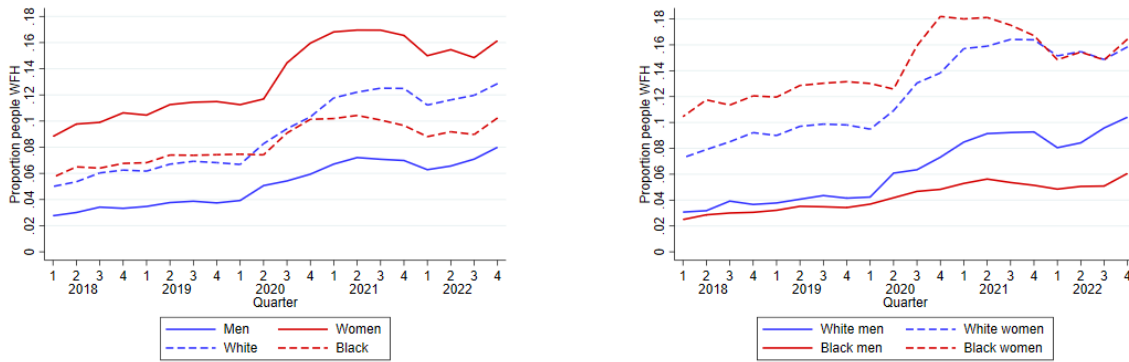
After dropping 2.8 percent of the sample with missing values for the dependent or independent variables, our final sample contained an unbalanced panel of 508,624 individuals across 20 quarters, totaling 1,261,448 observations. This sample included 63,230 individuals (11.5 percent) who worked remotely for at least one quarter. The largest share of these individuals never transitioned from WFO to WFH during the panel period (68.8 percent before and 75.7 percent during COVID-19), e.g., people (re-)entering the job market to work remotely. Fixed effects (explained below) control these cases. 17,442 individuals (3.2 percent) transitioned from WFO to WFH, and 15,976 individuals (2.9 percent) transitioned from WFH to WFO for at least one quarter. Transitions from WFO to WFH surpassed transitions from WFH to WFO before (3.2 percent versus 3 percent of the individuals) and during COVID-19 (3.1 percent versus 2.8 percent). Nineteen percent of the individuals who transitioned from WFO to WFH also shifted from private to self-employment. Similarly, 20 percent of the individuals who transitioned from WFH to WFO also shifted from self-employment to private employment.

3.2. Variables

Our explanatory variable of interest H was coded 1 when the individual worked mostly at home, and 0 when the individual worked from the office. PNADC asked respondents the following question: “Where did you mostly carry out this job [*onde você exercia normalmente este trabalho*]?” Distinguishing between WFH and WFO in this way allowed us to take into account both remote and hybrid work, as individuals working at home and the office during the reference week had to report their primary location of work. The data demonstrate that the COVID-19 pandemic accelerated the

rise of WFH among workers of all genders and races (Figure 2). The percentage of people WFH was higher among women than men, increasing from 9 percent in the 1st quarter of 2018 to 16 percent in the 4th quarter of 2022 (left panel). Interestingly, while remote work was more prevalent among Black workers than White workers before the pandemic, this pattern reversed after the start of the pandemic. When analyzing the data separating by both gender and race (right panel), Black and White women were found to be the most likely to WFH, followed by White men and Black men.

Figure 2. Proportion of People WFH



Source: Authors' calculations using sampling weights on data from PNADC from the 1st quarter of 2018 to the 4th quarter of 2022.

Our outcome variable Y is log monthly earnings in constant values as of November 2022 (Table 1), which serves as the foundation for labor contracts in Brazil. Earnings in the reference month encompass various forms of compensation, including wages, salaries, bonuses, and income from self-employment. Before COVID-19, the average earnings of remote workers were 33 percent lower than that of people WFO (R\$ 2,009 versus 3,019). That pattern reversed during COVID-19, with remote workers earning 13 percent more than those WFO (R\$ 3,199 versus 2,825). These results should be interpreted with caution because they could in part be due to WFH becoming positively selected during COVID-19, with an increasing representation of managers and professionals as well as those with tertiary education or who work longer hours (descriptive statistics in Appendix A). Our regression analyses (explained below) controlled for several time-variant characteristics (e.g., occupation and education) as time-invariant factors (e.g., skills and aptitudes).

Table 1. Average Earnings of People WFH and WFO

Gender/race	Before COVID-19		During COVID-19	
	WFH	WFO	WFH	WFO
Total	2,009.1 (3,833.1)	3,019.0 (4,243.5)	3,198.6 (5,584.0)	2,825.3 (3,710.0)
White men	4,205.4 (5,828.8)	4,203.7 (5,934.1)	6,076.9 (9,008.8)	3,823.9 (5,271.0)
White women	2,081.9 (4,713.7)	3,356.5 (4,844.0)	3,109.3 (4,610.9)	3,169.4 (3,848.9)
Black men	2,219.0 (2,854.7)	2,449.4 (2,624.1)	3,096.8 (4,328.1)	2,327.5 (2,561.4)
Black women	1,061.9 (1,287.7)	2,034.9 (2,057.6)	1,445.5 (2,343.9)	1,964.8 (1,843.2)

Source: Authors' calculations using sampling weights on data from PNADC.

Note: Earnings are in Brazilian Reais at constant values as of November 2022. Standard deviation estimates appear in parentheses. Before COVID-19 ranges from the 1st quarter of 2018 to the 1st quarter of 2020, and during COVID-19 ranges from the 2nd quarter of 2020 to the 4th quarter of 2022.

The descriptive statistics in Table 1 also show that the shifting landscape of remote work appeared to alter the earnings penalties associated with gender and race before and during COVID-19. For example, Black women WFH earned 48 percent less than their WFO peers before COVID-19 and 26 percent less during COVID-19. The earnings difference by WFH status for White women shrank from 38 percent to 2 percent during the same period. Among men, White men WFH earned the same as those WFO before COVID-19 but 59 percent more during COVID-19. A similar pattern was found for Black men but at a smaller magnitude, from a 9 percent earning penalty before COVID-19 to a 33 percent earning premium of remote work during the pandemic.

The control variables include level of education (up to primary as the reference, secondary, or tertiary education), age and age squared, working status (private employee as the reference, and self-employed), typical hours worked per week, whether one contributes to the public pension system (a proxy for informal work in Brazil), the industry one is employed in, and occupation. The industry sector category aggregated the 2-digit industry codes provided by the National Classification of Economic Activities—CNAE 2.0 (IBGE, 2021a)—into nine categories: agriculture; manufacturing; construction; retail and wholesale trade; transport and warehousing; accommodation and food services; arts, entertainment, and recreation; education, health, and social assistance; and other sectors (reference). For occupation, we used the parsimonious classification that aggregates occupations into nine categories (2-digit codes), provided by the Brazilian Classification of Occupations—*CBO-Domiciliar* (IBGE, 2021a): managers; professionals; technicians and mid-level professionals;

administrative support occupations; services and sales; skilled workers in agriculture; blue-collar workers (construction, extraction, and production); maintenance and repair workers; and unskilled elementary occupations (the reference). We conducted sensitivity analyses that controlled for more detailed 424 occupations (4-digit codes) and obtained similar results (explained below).

3.3. Methods

We used a panel fixed-effects model for the log earnings Y of individual i at quarter t (equation 1), separating the data into two periods p : before (between the 1st quarter of 2018 and the 1st quarter of 2020) and during COVID-19 (between the 2nd quarter of 2020 and the 4th quarter of 2022).

$$Y_{pit} = d_{pt} + \delta_{1p}H_{pit} + \sum_{j=2}^4 \delta_{jp}H_{pit}GR_{jpi} + \mathbf{x}_{pit}\boldsymbol{\beta}_p + c_{pi} + \varepsilon_{pit} \quad (1)$$

In the above equation, the coefficient δ_1 measures the net difference in log earnings between White men (the reference category) WFH (variable H) versus WFO, holding constant the control variables in vector $\mathbf{x}$; $\delta_1 > 0$ indicates an earnings premium, and $\delta_1 < 0$ indicates an earnings penalty; δ_j is the gap in earnings premium or penalty of WFH between White men and the j -th gender-race group ($GR_2 = 1$ for White women; $GR_3 = 1$ for Black men; and $GR_4 = 1$ for Black women). The earnings premium or penalty of WFH for White women (marginal effects) is $\delta_1 + \delta_2$, and so forth for the other groups.

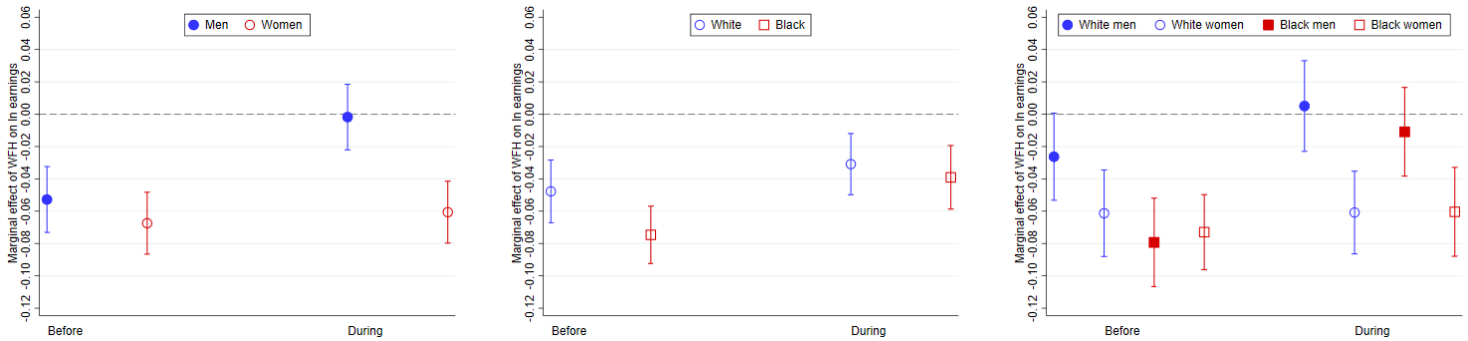
The component c is the individual fixed-effects that capture time-invariant unobserved individual-level heterogeneity (e.g., skills and aptitudes); d is the quarter dummy variable that captures seasonality and macroeconomic shocks; ε is the idiosyncratic error. The identification of race or gender differences in the earnings penalty (or premium) of WFH comes from individuals who switch between WFH and WFO (and vice-versa) as the fixed effect absorbs the main effects of race/gender.

4. Results

4.1. The Earnings Penalty of WFH by Gender and Race before and during COVID-19

Figure 3 presents the estimates of the earnings penalties of WFH from separate models before and during the pandemic (based on the estimates in Appendix B). We provide estimates by gender (left panel) and race (middle panel) separately and then in combination with each other (right panel).

Figure 3. Estimates of the Earnings Penalties of WFH



Source: Authors' calculations using sampling weights on data from PNADC.

Notes: The above graphs represent separate models for each period. The before COVID-19 period ranges from the 1st quarter of 2018 to the 1st quarter of 2020, and the during COVID-19 period ranges from the 2nd quarter of 2020 to the 4th quarter of 2022. The 95% confidence intervals were computed using robust standard errors. The control variables include level of education, age and age squared, working status, typical hours worked per week, whether one contributed to the public pension system, and binary variables for the industry one works in and occupation. The models incorporate individual fixed-effects and binary variables for the quarters.

In general, we found that the difference between the earnings penalty of men and women widened and became significant during the pandemic, while the difference between White workers and Black workers narrowed and became insignificant during the same period. Specifically, WFH carried a significantly negative earnings penalty for Brazilian men and women alike before COVID-19. However, this penalty dissipated for men while remaining high for women during the pandemic. With respect to racial differences, Black workers suffered from a steeper earnings penalty of WFH than their White peers before the pandemic. This penalty diminished for both groups during the pandemic and affected Black workers and White workers in a comparable manner.

In a similar vein, apart from White men, all of the groups (White women, Black men, and Black women) experienced a significant earnings penalty of WFH before the pandemic. While the earnings penalty of WFH continued to be significant for both groups of women during the pandemic, it became insignificant for Black and White men. The earnings penalty of White women was 3.5 percentage points ($p < 0.1$) higher than that of White men before the pandemic and 6.6 percentage points higher ($p < 0.001$) during the pandemic (Appendix B). By contrast, differences between White men and Black men were significant before the pandemic ($p < 0.01$) and insignificant during it.

Overall, in Brazil, White men who transitioned from WFO to WFH did not experience significant earnings losses before COVID-19, and these losses became even less noticeable during the pandemic. Black men benefited the most from an elimination of WFH's negative consequences during the pandemic. In contrast, both White and Black women continued to face substantial earnings penalties from WFH throughout the same period.

4.2. Robustness Checks

We check the robustness of the estimates against different sets of controls and empirical strategies (Appendix C). To simplify the analysis, these models combined the periods before and during COVID-19. The figures in Appendix D show the estimates of the earning penalties using the same models segmented by periods.

Model 0 is the benchmark used in our main analyses. Model 1 removes the controls for job characteristics and only retains the controls for human capital (age and education). The purpose of this was to examine whether the effects of WFH in Model 0 were linked to job mobility, such as transitioning to a new job with fewer working hours and/or skill requirements. The earnings penalties of WFH in Model 1 are nearly three percentage points higher than in Model 0. Shifting from an office-based job to a new home-based job typically suggests a more vulnerable position and higher earnings penalty than maintaining the same job but in a new work location. However, we cannot attribute gender and racial disparities in the earnings penalty of WFH to their shift to lower-quality positions.

Model 2 replaced the 2-digit occupation codes with more detailed 4-digit occupation codes. This model examines whether omitted occupational characteristics may affect the estimates, e.g., people shifting between occupations with similar levels of skill (occupations with the same 2-digit but different 4-digit codes). However, the estimates remained stable. We thus used the most parsimonious Model 0 (with the lowest BIC) for the main analyses.

Model 3 removes fixed-effects (pooled regression) to examine whether the earnings penalty of WFH might be driven by selection in the absence of controls for time-invariant unobservables, such as the higher likelihood of unskilled and low-wage workers engaging in remote work. The estimates now represent earning differences between people WFH versus WFO by gender and racial groups. The earnings differences associated with WFH in Model 3 are between three and six times higher than in Model 0. In other words, women and Black men are more likely to work remotely in unskilled and low-paying jobs compared to White men. During the pandemic, the negative selection

fell significantly for White women and Black men, while remaining high for Black women. White men WFH became positively selected.

Model 4 restricts the sample to a balanced panel (i.e., workers who remained employed during five quarters) but is otherwise identical to Model 0. This analysis tested the effect of sample attrition—whether people WFH were more likely to remain in the labor force. We obtained similar results for the differences between White men and Black women. The earnings gap estimates for White women and Black men, in comparison to White men, were not statistically significant at the 5 percent level. One limitation of Model 4 is that it relies on just a quarter of the sample, which compromises its statistical power.

Overall, the most robust estimates are for the earnings gap between White men and Black women WFH, suggesting that Black women were more severely penalized by WFH. The estimates from Model 0 also hold for White women and Black men once we relax the hypothesis of attrition in Model 3. We then conducted additional tests to determine how endogeneity may have significantly impacted our estimates.

Attrition may be a source of endogeneity, to the extent that the propensity to remain employed (i.e., in the data) may differ by personal characteristics that are associated with work arrangements (WFH or WFO). We tested for this possibility in Appendix E by regressing the probability of employment at quarter $t + 1$ as a function of remote work and controls at quarter t . The estimates were insignificant at 5 percent across all gender and racial groups, suggesting that attrition is not a main concern in our analyses.

Selection is another source of endogeneity that may affect the relation between WFH and earnings. Selection may also result from office performance. For example, those with poor performance may be more likely to work remotely. If the negative selection is present and is stronger for women than men, we might expect a higher earnings penalty for the former. Appendix F regressed the probability of WFH at quarter $t + 1$ as a function of log earnings and controls at quarter t . We found no evidence of such selection. Except for the small negative estimate for Black men, all other estimates were insignificant at 5 percent.

4.3. Mechanisms Linking WFH to Earnings Penalty

One potential mechanism linking WFH and gender and racial inequality is the equilibrium between the supply and demand of remote workers. If women were more likely than men to supply remote work in general and especially during the pandemic, we might expect a higher earnings penalty of WFH for women than for men. Differentiating between supply and demand is challenging since we only observe the equilibrium between supply and demand for remote jobs in the labor market. We demonstrated how a higher concentration of women WFH is related to an increasing earnings penalty for them.

Table 2 shows the estimates of linear probability models for two dependent variables: when individuals worked from home and when they worked in occupations that could feasibly be done from home. The latter variable has been defined by Goes et al. (2022b) based on a methodology proposed by Dingel and Neiman (2020). The estimates provide evidence that the likelihood of WFH rose during the pandemic, with women seeing the fastest rise. For example, the probability of WFH increased by 3.5 percentage points for men and 4.2 (3.5+0.7) percentage points for women. Additionally, during the pandemic, women also became more likely than men (by 0.7 percentage points) to transition into occupations that could be feasibly done from home. These findings may reflect both a higher willingness of women to work remotely (increasing supply) and a higher demand for remote jobs typically done by women, such as customer services, during the pandemic.

The figures in Appendix G illustrate the interaction between the earnings penalty of WFH and the proportion of individuals of the same gender and race WFH in the same occupation and state. Except for White men, the earnings penalty for WFH was significantly higher in occupations with a higher concentration of individuals from the same social group working remotely. These results together suggest that as the proportion of women WFH rises, so does their earnings penalty associate with WFH.

Table 2. Estimates of the Linear Probability Models for WFH and Occupation That Can Be Feasibly Done from Home

	WFH			Feasible		
	Gender only	Race only	Gender & Race	Gender only	Race only	Gender & Race
<i>Covid (reference)</i>	0.035*** (0.006)	0.043*** (0.006)	0.040*** (0.006)	-0.015* (0.007)	-0.013+ (0.007)	-0.016* (0.008)
<i>Covid × Women</i>	0.007** (0.003)			0.007* (0.003)		
<i>Covid × Black</i>		-0.009*** (0.002)			0.002 (0.003)	
<i>Covid × White women</i>			0.007+ (0.004)			0.009+ (0.005)
<i>Covid × Black men</i>			-0.009*** (0.003)			0.003 (0.004)
<i>Covid × Black women</i>			-0.002 (0.004)			0.009* (0.004)
Control variables	✓	✓	✓	✓	✓	✓
Individual fixed-effects	✓	✓	✓	✓	✓	✓
Binaries: quarters	✓	✓	✓	✓	✓	✓
Observations	1,261,448	1,261,448	1,261,448	1,261,448	1,261,448	1,261,448
AIC	-1,718,569	-1,718,608	-1,718,632	-1,139,853	-1,139,836	-1,139,852
BIC	-1,718,051	-1,718,090	-1,718,089	-1,139,431	-1,139,414	-1,139,406
Overall R²	0.168	0.165	0.169	0.204	0.202	0.204
Within R²	0.021	0.021	0.021	0.012	0.012	0.012
Between R²	0.199	0.195	0.199	0.227	0.225	0.227

Source: Authors' calculations using sampling weights on data from PNADC.

Notes: *** p<0.001; ** p<0.01; *p<0.05; + p<0.1. Robust standard error estimates are between parentheses. *Covid* is a binary variable that assumes 0 before COVID-19 (from the 1st quarter of 2018 to the 1st quarter of 2020) and 1 during COVID-19 (from the 2nd quarter of 2020 to the 4th quarter of 2022). Occupations that can be feasibly done from home are defined by Goes et al. (2022b). Control variables include level of education, age and age squared, working status, typical hours worked per week, whether one contributes to the public pension system, and binaries for industry worked in and occupations (except for the model for occupations that can be feasibly done from home).

The second mechanism is related to labor productivity: whether WFO workers perform better than WFH workers. Although we lack a measure of productivity per worker, we could measure the hours dedicated to work. Table 3 examines the effective working hours (how many hours the person actually worked in her/his primary job during the reference week) by WFH status over time and by gender and race. Because labor contracts in Brazil are based on the fixed working hours one works per week, self-reported effective working hours during the reference week provide some insights into dedication and performance on the job. The PNADC dataset contains both “usual” and “effective” working hours in the primary job during the reference week. While “usual” working hours generally represent the expected or contracted hours, effective working hours are more sensitive to periods of

crises and are commonly used to assess an underutilization of the labor force in Brazil (Carvalho, 2021). Although the estimates control for job characteristics, changes in effective working hours may also reflect transitions between jobs with similar characteristics but fewer working hours. The results suggest that WFH is generally correlated with fewer effective working hours than WFO. In addition, WFH was found to penalize women more than men. The difference between the effective working hours of White women and White men decreased during the pandemic, but Black women disproportionately remained affected by WFH over time. Differences between White men and Black men were insignificant before and during the pandemic.

Table 3. Estimates of the Models for Effective Working Hours at Quarter $t+1$

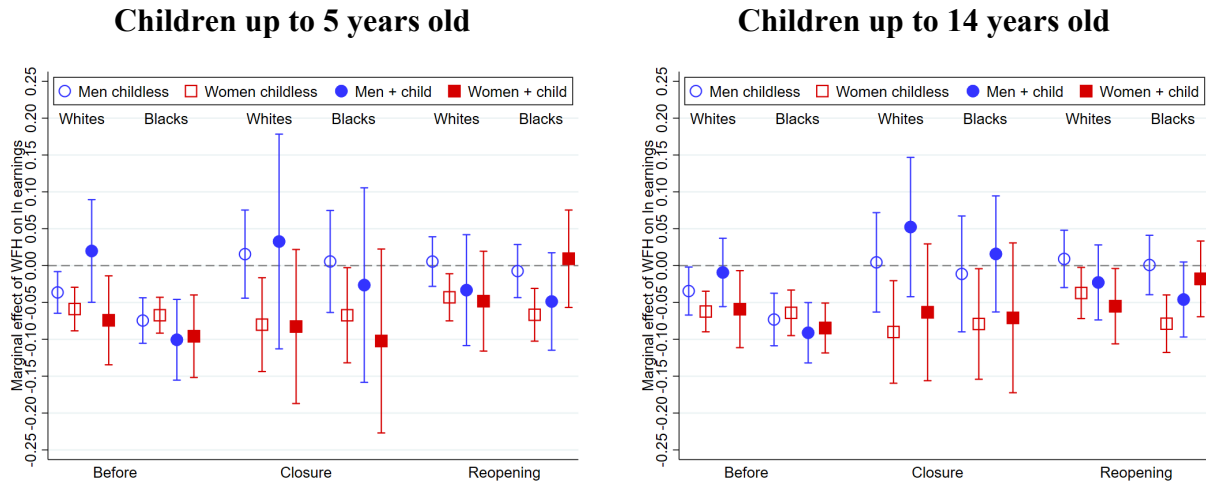
Variables	Gender		Race		Gender and Race	
	Before	During	Before	During	Before	During
WFH (reference)	-0.786*** (0.238)	-0.723** (0.230)	-1.632*** (0.207)	-0.607** (0.208)	-0.863** (0.327)	-0.697* (0.287)
WFH × Women	-1.411*** (0.312)	-0.505 (0.313)				
WFH × Black			-0.021 (0.263)	-0.892** (0.315)		
WFH × White women					-1.298** (0.422)	0.156 (0.411)
WFH × Black men					0.154 (0.429)	-0.062 (0.461)
WFH × Black women					-1.366*** (0.414)	-1.343** (0.421)
Control variables	✓	✓	✓	✓	✓	✓
Individual fixed-effects	✓	✓	✓	✓	✓	✓
Binaries: quarters	✓	✓	✓	✓	✓	✓
Observations	666,312	595,136	666,312	595,136	666,312	595,136
AIC	4,192,974	3,597,347	4,193,112	3,597,293	4,192,977	3,597,228
BIC	4,193,339	3,597,731	4,193,477	3,597,677	4,193,365	3,597,635
Overall R²	0.098	0.089	0.094	0.088	0.099	0.091
Within R²	0.013	0.014	0.013	0.014	0.013	0.014
Between R²	0.131	0.113	□ 0.125	0.112	□ 0.132	0.115

Source: Authors' calculations using sampling weights on data from PNADC.

Notes: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; + $p < 0.1$. Robust standard error estimates appear in parentheses. Before COVID-19 ranges from the 1st quarter of 2018 to the 1st quarter of 2020, and during COVID-19 ranges from the 2nd quarter of 2020 to the 4th quarter of 2022. Control variables include level of education, age and age squared, working status, whether one contributes to the public pension system, and binaries for industry worked in and occupation.

We ran one more test to see how the productivity channel affect the relation between WFH and earnings by interacting WFH with family status and school closure time—before the pandemic, during school closures (between the 2nd quarter of 2020 and the 3rd quarter of 2021), when most elementary schools remained in full or partial remote learning in Brazil, and after school reopenings. This analysis allowed us to study how family caregiving responsibilities (i.e., children) may have affected productivity WFH and therefore the gender and racial gap of the wage effects of WFH. Figure 5 displays the marginal effect of WFH on men without children, women without children, men with children, and women with children. We provide estimates by children up to 5 years old (left panel) and children up to 14 years old (right panel). We found little evidence that women with children at home during school closures were the most penalized for WFH. The earnings penalties of WFH for women with and without children (up to 5 or 14 years old) were similar.

Figure 4. Estimates of the Earnings Penalty of WFH by Family Status



Source: Authors' calculation using sampling weights on data from PNADC.

Notes: The 95% confidence intervals were computed using robust standard errors. There were separate models for each period. Before COVID-19 ranges from the 1st quarter of 2018 to the 1st quarter of 2020, during school closures ranges between the 2nd quarter of 2020 and the 3rd quarter of 2021, and reopening ranges from the 4th quarter of 2021 to the 4th quarter of 2022. The control variables include level of education, age and age squared, working status, typical hours worked per week, whether one contributes to the public pension system, and binary variables for industry worked in and occupation. The models incorporate individual fixed-effects and binary variables for quarters.

The third mechanism is related to visibility in the office, which affects opportunities for career advancement. The models in Table 4 evaluate the impacts of remote work at quarter t on the likelihood that a worker assumed a managerial position at quarter $t + 1$, before and during the

pandemic. The results show that WFH men were less likely to assume managerial occupations than their WFO peers before COVID-19, while WFH women were more likely than WFH men to assume managerial occupations during this time. Following the onset of the pandemic, WFH women became less likely than WFH men to assume managerial occupations. This pattern was especially driven by White women. In other words, WFH undermined the promotion of White women during COVID-19.

Table 4. Estimates of the Linear Probability Models for Being a Manager at Quarter $t+1$

Variables	Gender		Race		Gender and race	
	Before	During	Before	During	Before	During
WFH (reference)	-0.007+ (0.004)	0.007 (0.006)	-0.003 (0.003)	-0.008 (0.006)	-0.008 (0.006)	0.010 (0.009)
WFH × Women	0.010* (0.005)	-0.022** (0.007)				
WFH × Black			0.003 (0.004)	0.008 (0.007)		
WFH × White women					0.009 (0.007)	-0.034** (0.011)
WFH × Black men					0.002 (0.006)	-0.007 (0.013)
WFH × Black women					0.012+ (0.006)	-0.013 (0.009)
Control variables	✓	✓	✓	✓	✓	✓
Individual fixed-effects	✓	✓	✓	✓	✓	✓
Binaries: quarters	✓	✓	✓	✓	✓	✓
Observations	378,073	314,566	378,073	314,566	378,073	314,566
AIC	-678,738	-671,901	-678,729	-671,851	-678,735	-671,933
BIC	-678,380	-671,538	-678,371	-671,489	-678,355	-671,549
Overall R²	0.351	0.387	0.351	0.391	0.351	0.387
Within R²	0.064	0.048	0.064	0.048	0.064	0.048
Between R²	0.575	0.533	0.575	0.539	0.576	0.534

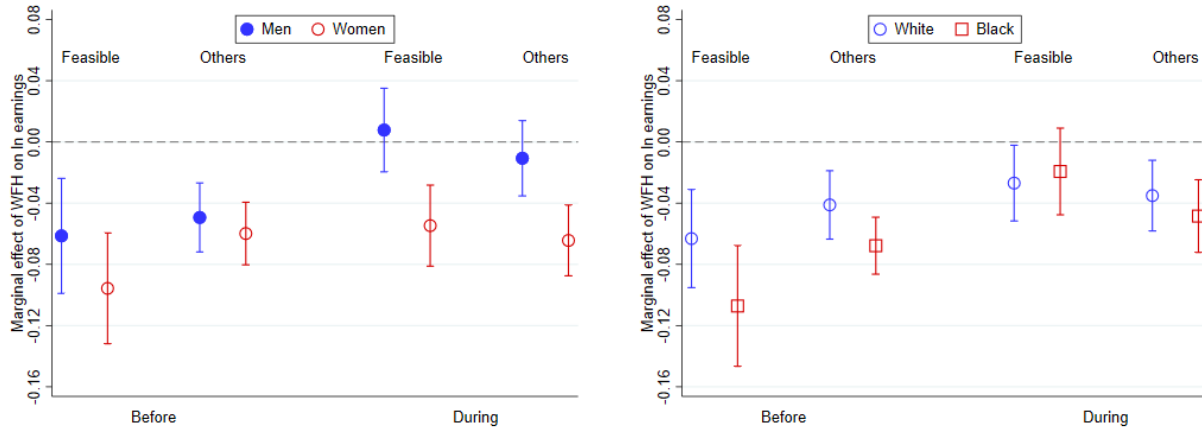
Source: Authors' calculations using sampling weights on data from PNADC.

Notes: *** p<0.001; ** p<0.01; *p<0.05; + p<0.1. Robust standard error estimates appear in parentheses. Before COVID-19 ranges from the 1st quarter of 2018 to the 1st quarter of 2020, and during COVID-19 ranges from the 2nd quarter of 2020 to the 4th quarter of 2022. Control variables include level of education, age and age squared, working status, whether one contributes to the public pension system, and binaries for industry employed in and occupation.

4.4. Heterogeneity by Occupation

Figure 5 displays the marginal effects of WFH (at a 95% confidence interval) for occupations that can be feasibly done from home and other occupations. This analysis examines how technological advances, which facilitate access and reduce the costs of WFH, may mitigate the earnings penalty of WFH in general and for traditionally disadvantaged groups (women and Blacks). We do not show gender-race results because of their small sample size and large standard errors.

Figure 5. Estimates of the Earnings Penalty of WFH by Occupation



Source: Authors' calculation using sampling weights on data from PNADC.

Notes: The 95% confidence intervals were computed using robust standard errors. Separate models are displayed for each period. Before COVID-19 ranges from the 1st quarter of 2018 to the 1st quarter of 2020, and during COVID-19 ranges from the 2nd quarter of 2020 to the 4th quarter of 2022. Occupations that can be feasibly done from home are defined by Goes et al. (2022b). The control variables include level of education, age and age squared, working status, typical hours worked per week, whether one contributes to the public pension system, and binary variables for industry one works in and occupation. The models incorporate individual fixed-effects and binary variables for quarters.

The results show that the pandemic significantly reduced the earnings penalties of Black individuals WFH in occupations that could feasibly be done from home. The earnings penalty of Black individuals WFH in these occupations became insignificant during the pandemic, while remaining significant for their WFH peers in other occupations. During the pandemic, women WFH in both types of occupations continued to be equally penalized, while this penalty disappeared for men WFH in both types of occupation. If anything, WFH appears to have benefitted Black workers more in occupations that could feasibly be done from home.

5. Discussion

We utilized a large, nationally representative longitudinal dataset to examine the earnings penalty of WFH by gender and race before and during the COVID-19 pandemic in Brazil. We found that the earnings penalty of WFH fell for men (especially Black men) during the pandemic, while remaining high for women (both White and Black). People who shifted from WFO to WFH (and vice-versa) experienced an average earnings penalty (or earnings premium from WFH to WFO) ranging from nearly 0 percent for White men to 7 percent for Black women.

We found no evidence that these results were affected by attrition or selectivity. Regardless of gender and race, there was no significant association between WFH and the probability of remaining employed (attrition). Poor performance in the office was also not significantly linked to the likelihood of WFH (selection). Still, we could not necessarily conclude that these results reflect a causal effect of WFH, as people who shifted from WFO to WFH may have suffered setbacks that could have also affected their job performance in the office (parallel trend assumption). Nevertheless, we provided evidence that transitions from office to remote work have disproportionately penalized women. The study also examined three mechanisms that potentially explain the observed challenges faced by women WFH: the equilibrium between supply and demand for WFH, labor productivity, and promotion.

Women were overrepresented in remote jobs and became more likely than men with similar characteristics to switch from an office to a home-based occupation during the pandemic. One possible explanation for the greater incidence of women WFH is that they are more likely to be employed in occupations that allow for remote work, such as customer service and administrative work. Additionally, Brazilian schools remained closed for nearly one and a half years during the pandemic (one of the most prolonged periods worldwide), which likely compelled more women with children (and in similar jobs than men) to work remotely while managing their household responsibilities. The overrepresentation of women in remote jobs had a negative effect on the earnings penalty they incurred from WFH. As the share of women WFH in one occupation rose, their earnings penalty from WFH also increased. Among other factors, employers could have offered lower salaries in response to an oversupply of women willing to attain WFH roles. We did not find a significant relationship between the percentage of men WFH and the earnings penalty they incurred from WFH, most likely because the proportion of men willing to forgo higher pay in exchange for the greater flexibility of working from home was less substantial.

Women WFH were also found to have dedicated fewer effective hours to their jobs than men, potentially compromising their job performance unless their productivity gains offset this decrease. The gap in hours allocated to work fell for White women during the pandemic, while remaining high for Black women. Technological advancements introduced during the pandemic may have helped White women WFH close the gap in the number of hours they spent working compared to men. On the other hand, Black households often have to contend with challenging infrastructure and social conditions, making it more difficult for Black women to balance their work from home with their

household responsibilities. Such difficulties extend beyond childcare and may have also included negative perceptions toward women WFH for family purposes, as women with and without children at home were equally penalized when WFH, even during school closures.

White women shifting from WFO to WFH also became less likely than White men to be promoted to managerial occupations during the pandemic. The effect of WFH was the opposite before the pandemic probably because men with career ambitions may have avoided WFH out of concern that the isolation would reduce their visibility and thereby chances of promotion (negative selection). However, during the pandemic, all groups of workers were involuntarily forced to work remotely due to mandatory stay-at-home orders, and the effect of WFH on women's promotion become evident. In contrast, Black women in managerial occupations are generally scarce in Brazil, and this scenario is hardly affected by WFH.

One way to reduce the earnings penalty of WFH, particularly between White and Black workers, is developing technologies that make WFH more accessible for some occupations. During the pandemic, the earnings penalty of WFH disappeared for Black workers in occupations that could feasibly be done from home using IT technologies, while remaining high in other occupations. IT advancements implemented during the pandemic, such as those relating to internet infrastructure and video conferencing platforms, could have improved people's job performance and their visibility at home while reduced employers' costs of offering WFH. In other words, IT advances could have reduced the negative perceptions associated with the selection of Black individuals into WFH, as well as improved the low productivity that is associated with the comparatively poorer infrastructure in Black households.

While we account for the earnings penalty gap between gender and racial groups before and during the pandemic, more research is still needed to develop a comprehensive understanding of the factors that underlie the earnings gap of WFH. For example, future researchers might evaluate how policies to mitigate the social prejudice against men and women WFH (flexibility stigma) may affect the earnings penalty of WFH. Understanding such differences and underlying mechanisms that explain how WFH affects earnings is particularly important in developing countries with a history of pronounced social inequalities.

The main policy implication of this study is that measures to stimulate remote work may inadvertently have detrimental impacts on gender and racial pay equality when they are not accompanied by changes in the social and labor norms responsible for the earnings penalty of WFH.

Part of the gender and racial earnings gap associated with WFH reflects historical asymmetries of the Brazilian labor market (Kassouf, 1998). WFH in Brazil has been linked to low-paying jobs, and this association is higher for women. The earnings differentials between men and women WFH are higher when we do not control for unobservable characteristics, which may reflect market segmentation in Brazil, such as differences between men and women workers with different levels of labor rights or social protection.

Independent of the labor segmentation, the transition from WFO to WFH also disproportionately disadvantages women. Reducing the asymmetry in the distribution of women and men working remotely may be a way to reduce the gender earnings penalty gap of WFH, as the earnings penalty is directly associated with the share of people of the same gender WFH. For example, companies should put into place policies that are supportive of work-life balance and work cultures in which WFH is not stigmatized as a women's issue (Villamor et al., 2023). Finding the right balance between in-office and remote work remains a challenge for fostering a more inclusive workplace.

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Appendix A. Sample Size, Average Values for People WFH, and Percentage of People WFH

Variable	Before COVID-19				During COVID-19			
	White men	White women	Black men	Black women	White men	White women	Black men	Black women
Sample size (WFO)	151,745	120,953	215,595	130,948	130,434	103,429	190,478	110,510
Sample size (WFH)	6,117	12,717	7,812	20,425	10,152	17,489	9,860	22,784
Education (%)								
Primary	2.8	14.7	3.4	20.7	3.2	17.3	3.5	21.8
Secondary	3.6	9.3	3.1	11.7	4.9	12.4	4.3	15.7
Superior	5.4	7.3	5.8	7.6	13.7	15.6	11.8	15.3
Age (years)	40.0	40.1	39.6	39.7	37.8	38.6	37.8	38.5
	(8.4)	(8.3)	(8.3)	(8.4)	(8.4)	(8.2)	(8.4)	(8.3)
Working status (%)								
Privately employed	0.4	0.8	0.3	0.8	3.9	5.0	1.5	3.0
Self-employed	12.1	31.1	10.4	39.4	15.1	37.2	12.3	45.6
Hours per week (h)	37.8	30.1	37.2	28.1	39.2	32.9	38.4	30.1
	(14.3)	(15.6)	(15.1)	(16.1)	(12.6)	(14.7)	(14.3)	(15.7)
Public pension (%)	2.1	4.2	1.4	3.7	5.9	9.4	3.0	7.1
Industry (%)								
Agriculture	1.5	16.4	2.9	36.8	0.6	11.8	1.6	28.7
Manufacturing	2.8	16.9	3.7	28.0	4.0	19.4	3.9	27.7
Construction	1.4	5.7	0.9	4.1	2.1	10.1	1.4	9.3
Trade	3.7	7.8	4.0	11.6	5.1	11.2	4.8	14.9
Transport	1.8	3.7	1.6	3.5	3.0	7.7	1.8	8.4
Accommodation	4.6	18.6	4.9	18.4	6.6	23.4	6.7	24.3
Entertainment	6.9	7.1	4.4	3.7	17.3	18.3	9.8	13.2
Education	2.2	1.7	1.8	2.5	5.5	5.6	4.1	4.6
Others	7.4	15.1	9.8	21.9	10.4	19.0	12.1	25.5
Occupation (%)								
Manager	1.5	2.1	1.4	1.5	8.9	10.0	4.4	6.0
Professional	7.4	6.7	8.8	7.4	18.8	16.6	18.7	17.2
Technician	5.3	5.5	3.8	3.4	8.8	10.5	6.6	7.1
Administrative	0.7	0.7	0.7	0.6	3.8	4.1	2.3	4.5
Sales	4.3	12.4	4.9	16.7	5.5	16.0	6.3	20.6
Farming	4.6	19.9	3.1	20.4	4.7	15.6	2.2	20.9
Blue-collar	3.8	40.4	3.7	50.6	4.3	43.3	4.2	53.2
Maintenance	1.7	13.3	2.3	18.2	1.7	15.2	1.9	18.5
Elementary	1.5	2.2	1.1	2.8	1.8	2.9	1.2	2.7

Source: Authors' calculations using sampling weights on data from PNADC.

Note: Standard deviation estimates appear in parentheses. Before COVID-19 ranges from the 1st quarter of 2018 to the 1st quarter of 2020, and during COVID-19 ranges from the 2nd quarter of 2020 to the 4th quarter of 2022.

Appendix B. Estimates of the Models for Log Earnings

Variable	Gender alone			Race alone			Gender and race				
	(1) Before	(2) During	χ^2 (1)=(2)	(1) Before	(2) During	χ^2 (1)=(2)	(1) Before	(2) During	χ^2 (1)=(2)		
WFH (reference)	−0.053*** (0.010)	−0.002 (0.010)	18.93***	−0.048*** (0.010)	−0.031** (0.010)	2.40	−0.027+ (0.014)	0.005 (0.014)	B	3.92*	
WFH × Women	−0.015 (0.014)	−0.059*** (0.014)	7.64**								
WFH × Black				−0.027* (0.012)	−0.008 (0.014)	1.64					
WFH × White women							−0.035+ (0.019)	A −0.066*** (0.019)	A	2.03	
WFH × Black men							−0.053** (0.018)	A −0.016 (0.020)	B	2.89+	
WFH × Black women							−0.046* (0.018)	A −0.065** (0.020)	A	0.79	
Control variables	✓	✓		✓	✓		✓	✓			
Individual fixed-effects	✓	✓		✓	✓		✓	✓			
Binaries for quarters	✓	✓		✓	✓		✓	✓			
Observations	666,312	595,136		666,312	595,136		666,312	595,136			
AIC	60,480	−12,838		60,454	−12,710		60,433	−12,838			
BIC	60,857	−12,442		60,831	−12,315		60,833	−12,420			
Overall R²	0.353	0.347		0.354	0.344		0.354	0.347			
Within R²	0.055	0.053		0.055	0.053		0.055	0.053			
Between R²	0.419	0.397	□ □	0.420	0.394	□	0.420	□ 0.397	□ □		

Source: Authors' calculations using sampling weights on data from PNADC.

Notes: *** p<0.001; ** p<0.01; *p<0.05; + p<0.1. Robust standard error estimates appear in parentheses. Before COVID-19 ranges from the 1st quarter of 2018 to the 1st quarter of 2020, and during COVID-19 ranges from the 2nd quarter of 2020 to the 4th quarter of 2022. Control variables include level of education, age and age squared, working status, typical hours worked per week, whether one contributes to the public pension system, and binaries for industry worked in and occupation. The null hypothesis in the χ^2 Wald test is that the estimates (1)=(2). The letters A and B represent pairwise comparisons across the estimates of the marginal effects for levels of gender and race. If two categories share the same letter, it indicates that there is no statistically significant difference between them at 10%.

Appendix C. Estimates of the Models for Log Earnings by Empirical Strategy

	Gender					Race				
	Bench- mark (0)	No Job Char. (1)	4-digits Occ. (2)	Pooled Reg. (3)	Balanced Panel (4)	Bench- mark (0)	No Job Char. (1)	4-digits Occ. (2)	Pooled Reg. (3)	Balanced Panel (4)
WFH (reference)	−0.023** (0.007)	−0.053*** (0.007)	−0.022** (0.007)	−0.001 (0.007)	−0.017 (0.012)	−0.039*** (0.007)	−0.070*** (0.007)	−0.036*** (0.007)	−0.107*** (0.006)	−0.031** (0.011)
WFH × Women	−0.045*** (0.010)	−0.053*** (0.010)	−0.040*** (0.010)	−0.243*** (0.008)	−0.042** (0.016)					
WFH × Black						−0.021* (0.009)	−0.029** (0.009)	−0.020* (0.009)	−0.191*** (0.008)	−0.021 (0.015)
WFH × White women										
WFH × Black man										
WFH × Black woman										
Age and education	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Job characteristics	✓	×	✓	✓	✓	✓	×	✓	✓	✓
4-digits occupations	×	×	✓	×	×	×	×	✓	×	×
Individual fixed-effects	✓	✓	✓	×	✓	✓	✓	✓	×	✓
Binaries for quarters	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	1,261,448	1,261,448	1,261,448	1,261,448	343,045	1,261,448	1,261,448	1,261,448	1,261,448	343,045
AIC	132,607	187,390	127,861	2,333,714	61,907	132,715	187,511	127,944	2,353,995	61,933
BIC	133,137	187,691	133,355	2,334,268	62,379	133,245	187,813	133,438	2,354,549	62,405
Overall R²	0.334	0.097	0.343	0.471	0.288	0.333	0.094	0.343	0.462	0.287
Within R²	0.063	0.022	0.067		0.056	0.063	0.022	0.067		0.056
Between R²	0.394	0.109	0.402	□	0.362	0.393	0.105	0.401	□	0.361

Source: Authors' calculations using sampling weights on data from PNADC.

Notes: *** p<0.001; ** p<0.01; *p<0.05; + p<0.1. The period includes the 1st quarter of 2018 to the 4th quarter of 2022. Robust standard error estimates appear in parentheses. Controls for age and education include level of education, age and age squared. Controls for job characteristics include working status, typical hours worked per week, whether one contributes to the public pension system, and binaries for industry worked in and occupation. Model 3 also includes controls for gender and race.

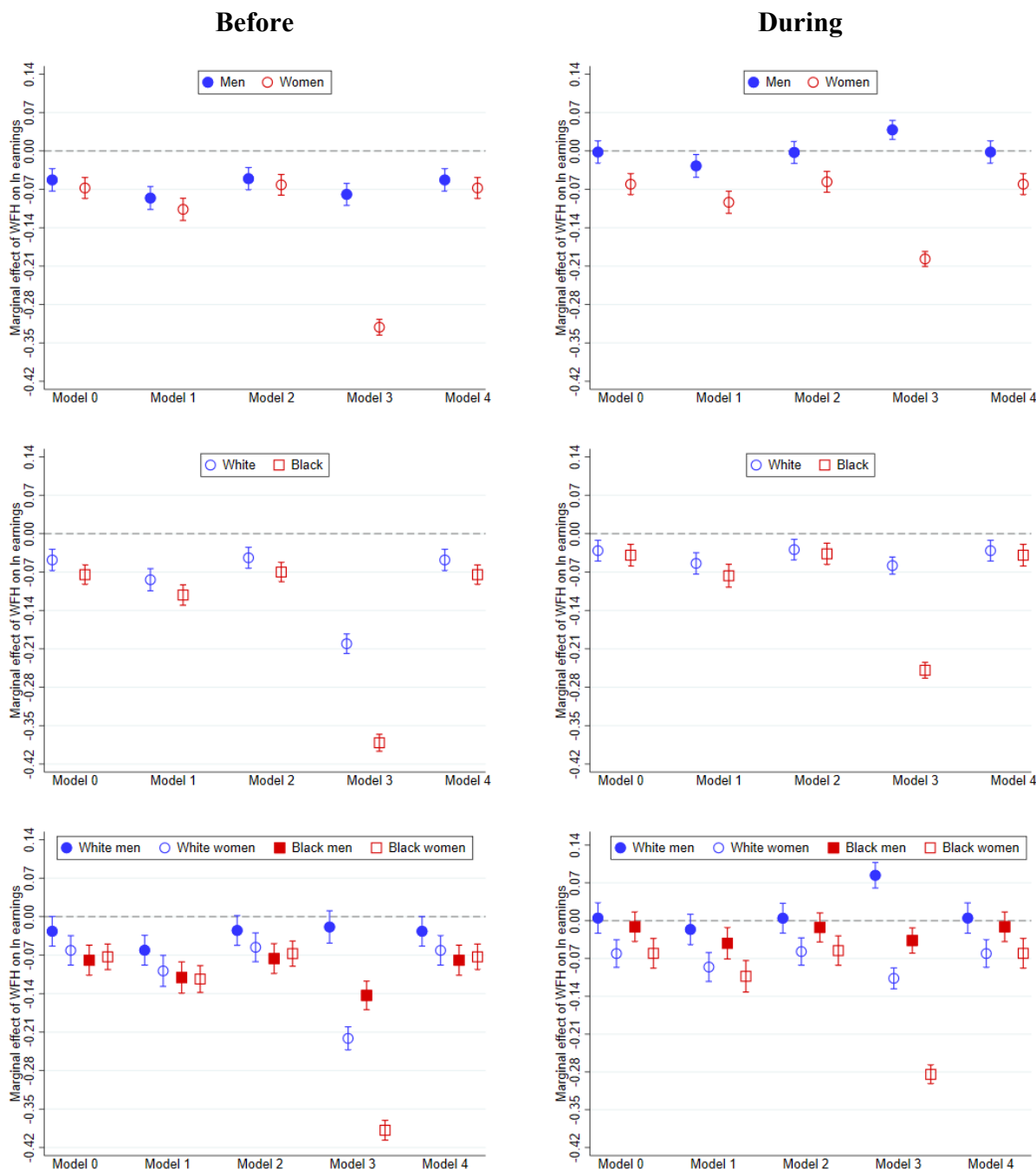
Appendix C., continued

	Gender and Race				
	Bench- mark (0)	No Job Char. (1)	4-digits Occ. (2)	Pooled Reg. (3)	Balanced Panel (4)
WFH (<i>reference</i>)	−0.006 (0.010)	−0.033*** (0.010)	−0.005 (0.010)	0.050*** (0.010)	−0.012 (0.016)
WFH × Women					
WFH × Black					
WFH × White women	−0.058*** (0.014)	−0.064*** (0.014)	−0.054*** (0.013)	−0.198*** (0.012)	−0.034 (0.021)
WFH × Black men	−0.037** (0.013)	−0.043** (0.014)	−0.036** (0.013)	−0.123*** (0.013)	−0.011 (0.022)
WFH × Black women	−0.066*** (0.013)	−0.082*** (0.014)	−0.060*** (0.013)	−0.374*** (0.011)	−0.064** (0.022)
Age and education	✓	✓	✓	✓	✓
Job characteristics	✓	×	✓	✓	✓
4-digits occupations	×	×	✓	×	×
Individual fixed-effects	✓	✓	✓	×	✓
Binaries for quarters	✓	✓	✓	✓	✓
Observations	1,261,448	1,261,448	1,261,448	1,261,448	343,045
AIC	132,560	187,316	127,816	2,309,400	61,897
BIC	133,114	187,641	133,334	2,310,002	62,392
Overall R²	0.335	0.100	0.344	0.481	0.289
Within R²	0.063	0.022	0.067		0.056
Between R²	0.395	0.113	0.403	□	0.364

Source: Authors' calculations using sampling weights on data from PNADC.

Notes: *** p<0.001; ** p<0.01; *p<0.05; + p<0.1. The period includes the 1st quarter of 2018 to the 4th quarter of 2022. Robust standard error estimates appear in parentheses. Controls for age and education include level of education, age and age squared. Controls for job characteristics include working status, typical hours worked per week, whether one contributes to the public pension system, and binaries for industry worked in and occupation. Model 3 also includes controls for gender and race.

Appendix D. Estimates of the Earnings Penalty of WFH by Empirical Strategy



Source: Authors' calculations using sampling weights on data from PNADC.

Notes: Separate models are shown for each period. Before COVID-19 ranges from the 1st quarter of 2018 to the 1st quarter of 2020, and during COVID-19 ranges from the 2nd quarter of 2020 to the 4th quarter of 2022. The 95% confidence intervals were computed using robust standard errors. The benchmark model 0 includes control from age and education, job characteristics, individual fixed-effects, and binaries for quarters. Model 1 excludes controls for job characteristics. Model 2 replaces 2-digits occupations with 4-digits occupations. Model 3 is a pooled regression without fixed-effects. Model 4 restricts the sample to a balanced panel.

Appendix E. Estimates of the Linear Probability Models for Employment at Quarter $t + 1$

	Gender		Race		Gender and race	
	Before	During	Before	During	Before	During
WFH (<i>reference</i>)	−0.004 (0.006)	−0.008 (0.009)	−0.005 (0.007)	−0.007 (0.008)	0.006 (0.009)	−0.002 (0.013)
WFH × Women	0.002 (0.010)	0.002 (0.012)				
WFH × Black			0.005 (0.009)	0.001 (0.011)		
WFH × White women					−0.018 (0.013)	−0.009 (0.016)
WFH × Black men					−0.020+ (0.012)	−0.013 (0.017)
WFH × Black women					0.001 (0.013)	0.003 (0.018)
Control variables	✓	✓	✓	✓	✓	✓
Individual fixed-effects	✓	✓	✓	✓	✓	✓
Binaries for quarters	✓	✓	✓	✓	✓	✓
Observations	479,206	371,231	479,206	371,231	479,206	371,231
AIC	−283,728	−379,329	−283,729	−379,329	−283,748	−379,333
BIC	−283,362	−378,961	−283,363	−378,961	−283,360	−378,944
Overall R²	0.011	0.004	0.011	0.004	0.011	0.004
Within R²	0.064	0.022	0.064	0.022	0.064	0.022
Between R²	0.003	0.002	0.003	0.002	0.003	0.002

Source: Authors' calculations using sampling weights on data from PNADC.

Notes: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; + $p < 0.1$. Robust standard error estimates appear in parentheses. Before COVID-19 ranges from the 1st quarter of 2018 to the 1st quarter of 2020, and during COVID-19 ranges from the 2nd quarter of 2020 to the 4th quarter of 2022. Control variables include level of education, age and age squared, working status, typical hours worked per week, whether one contributes to the public pension system, and binaries for industry worked in and occupation.

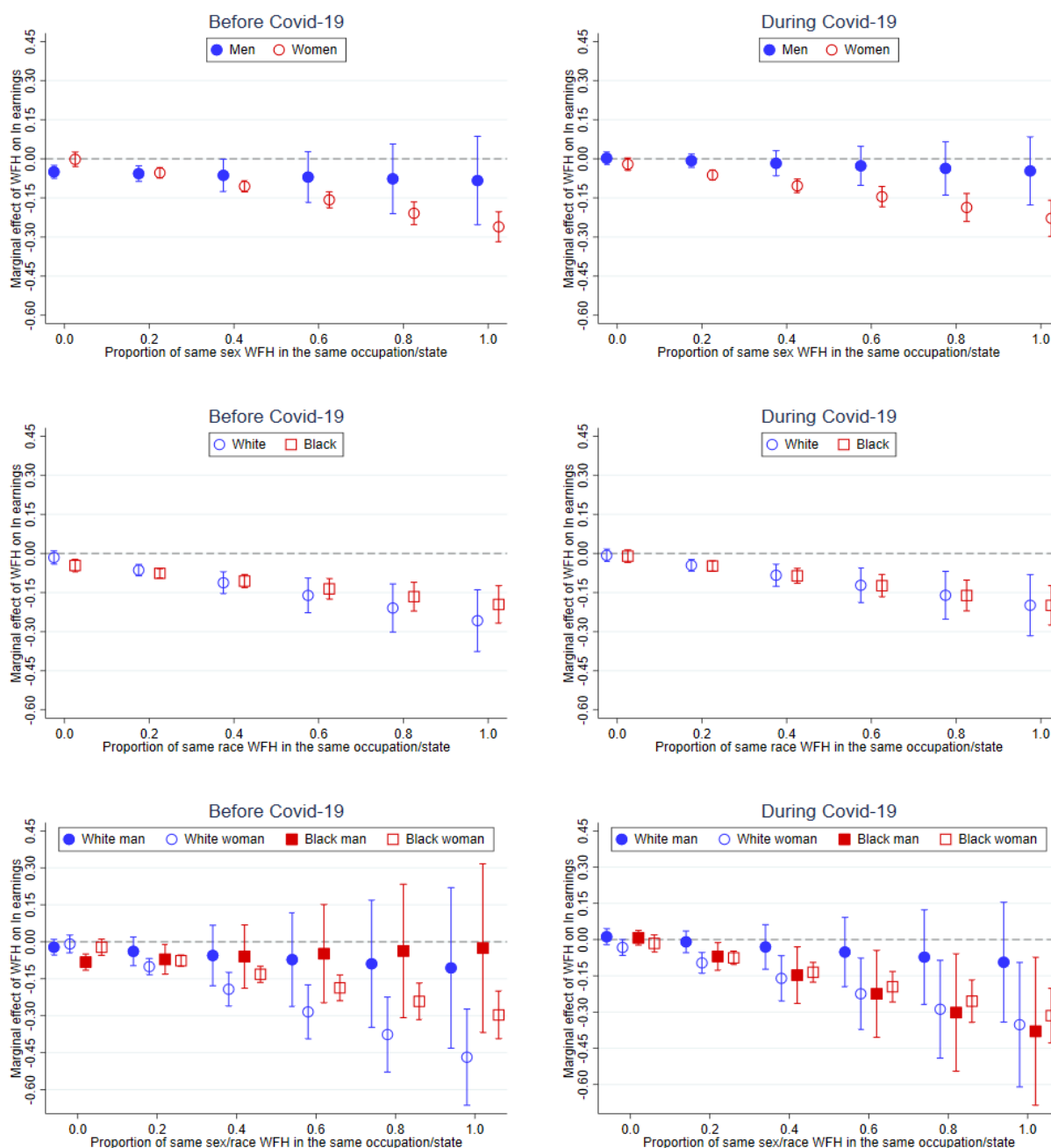
Appendix F. Estimates of the Linear Probability Models for WFH at Quarter $t+1$

Variable	Gender		Race		Gender and race	
	Before	During	Before	During	Before	During
ln earnings (<i>reference</i>)	0.003 (0.002)	0.003 (0.003)	0.002 (0.002)	0.001 (0.002)	0.003 (0.002)	0.004 (0.003)
ln earnings × Women	−0.002 (0.004)	−0.005 (0.005)				
ln earnings × Black			0.000 (0.000)	−0.001 (0.001)		
ln earnings × White women					−0.001 (0.004)	−0.007 (0.005)
ln earnings × Black men					0.000 (0.000)	−0.002* (0.001)
ln earnings × Black women					−0.002 (0.004)	−0.006 (0.005)
Control variables	✓	✓	✓	✓	✓	✓
Individual fixe-effects	✓	✓	✓	✓	✓	✓
Binaries: quarters	✓	✓	✓	✓	✓	✓
Observations	378,073	314,566	378,073	314,566	378,073	314,566
AIC	−638,699	−484,654	−638,701	−484,655	−638,703	−484,671
BIC	−638,341	−484,292	−638,344	−484,293	−638,323	−484,288
Overall R²	0.001	0.004	0.001	0.006	0.001	0.002
Within R²	0.001	0.002	0.001	0.002	0.001	0.002
Between R²	0.001	0.005	0.001	0.008	0.002	0.003

Source: Authors' calculations using sampling weights on data from PNADC.

Notes: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; + $p < 0.1$. Robust standard error estimates appear in parentheses. Before COVID-19 ranges from the 1st quarter of 2018 to the 1st quarter of 2020, and during COVID-19 ranges from the 2nd quarter of 2020 to the 4th quarter of 2022. Control variables include level of education, age and age squared, working status, typical hours worked per week, whether one contributes to the public pension system, and binaries for industry worked in and occupation.

Appendix G. Estimates of the Earnings Penalty of WFH in Interaction with the Share of Same-Sex/race People WFH in the Same Occupation/State



Source: Authors' calculations using sampling weights on data from PNADC.

Notes: The estimates are based on data from PNADC and use sampling weights. Before COVID-19 ranges from the 1st quarter of 2018 to the 1st quarter of 2020, and during COVID-19 ranges from the 2nd quarter of 2020 to the 4th quarter of 2022. The 95% confidence intervals were computed using robust standard errors. The control variables include level of education, age and age squared, working status, typical hours worked per week, whether one contributes to the public pension system, and binary variables for industry worked in and occupation. The models incorporate individual fixed-effects and binary variables for quarters.